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THE TELEPHONE AND THE "EDINBURGH REVIEW."

IT was complained of some of the older Edinburgh Reviewers, that they utilised the books, of which a list was prefixed to their articles, less for the purposes of review than as an excuse for expressing their own opinions on, or writing a history of, the subjects dealt with. An article in the "Edinburgh" for January, on "Telephones in Great Britain," shows that the qualification of using the titles of publications as a peg upon which to hang a practical disquisition, has not been lost. Treasury Minutes, Reports of Select Committees, Memorandum setting forth Agreements, Annual Reports of the Postmaster-General, and semi-annual Reports of the National Telephone Co., are supposed to be the subjects of review. They serve instead for a concise history, some interesting speculative questions, and a final recommendation. It was a celebrated historian who said, in an "Edinburgh" review, that to have spoken history, acted history, and lived history, formed "one eminent qualification for writing history."

Whilst it is useless to conjecture the relationship of the writer to the subject of the article, it is safe, we think, to say that his knowledge on the historic side has not been acquired solely from a perusal of the undoubtedly illuminating works quoted. Speculative questions are reached as early as the fourth line of the article:—

"Whether an industrial undertaking, such as the conduct of telephone exchanges, is likely to be more beneficial to the public in the hands of the State, of municipalities, or of private enterprise; whether the State can, in such an undertaking, successfully compete with private agencies; what is the value of competition at all; and what the advantages of a monopoly in relation to such an enterprise—these are some of the questions which arise in connection with the development of telephonic communication in this country."

Dealing with the Telegraph Act of 1868, the Reviewer remarks that "obviously, the telegraphs were not handed over to the Post Office in order that they might be farmed, or that telegraphic communication should be obstructed or made more expensive." The competition of the Telephone Company with the Government telegraphs, and the encouragement of competitive telephone companies, are duly recorded. Of Mr. Hanbury's Committee the Reviewer writes in mild reproof:—"The difficulties in formulating any satisfactory policy, inherent in the fact that the Post Office had abnegated its true function of carrying on telephonic work, and had let a portion of its monopoly out to farm, were ignored, and the telephone question was treated too much as a contest between the company, supported by the Post Office, and the municipalities, representing the public. In the course of the evidence, the complications of

the situation, however, gradually developed, and in its Report the Committee, though still taking too controversial a tone, made recommendations which have undoubtedly resulted in advantage to the public."

It is recognised, however, that the main purpose of Mr. Hanbury's Committee was to inquire into the advantages of municipal competition, and in the Reviewer's opinion, "there are many lions in the path of municipal telephone enterprise," and "to carry on a telephone undertaking at the risk of the rates is, therefore, a project of very questionable propriety." It is recognised, also, that competition by the Post Office presents "some awkward features" not noticed by the Committee, and it is considered that their recommendations may be challenged, on the ground that "the principles of competition cannot be usefully applied to the telephone;" but the charge which is legitimately made against the Report, is not that the Committee recommended competition, "but that it did not make it sufficiently clear that competition was but a temporary makeshift, and that the only ultimate solution lay in the resumption by the Postmaster-General of the duty of working the whole telephone system in connection with the administration of the Post Office."

An extension of the company's license is regarded as impolitic and impracticable, and the solution suggested is Government purchase by terminable annuities. "In the final deal the Government has the better hand, if it only makes the most of its cards; and it is for the company to play first." In these words the Reviewer concludes his article, which should be read by all interested in the subject. We may reserve comment on the proferred solution, but we cannot peruse the catalogue of mistaken policies without recalling our efforts to prevent their perpetration. Scarcely one of the failures recorded but has been set forth by us in its true light when first proposed. We hope that the title of the "Edinburgh" article will not be considered as another Irish grievance, but there is some ground for it where "Great Britain" takes the place of the "United Kingdom." It may truly be asked, What has Ireland done to justify this omission? Are there no telephones in Ireland? Has not the distressful country provided patriot or Parliamentarian to claim freedom for the telephone as well as for the people? Is Dwyer Gray forgotten?

THE RATING OF TRAMWAYS AND LIGHT RAILWAYS.

At the meeting of the Tramways and Light Railways Association, which was held on January 28th, Mr. W. G. Bond read a paper, in the course of which he sketched the existing law applicable to the rating of tramways and light railways, and pointed out certain respects in which he considers that law should be altered. It is hardly necessary to remark that this subject is of the greatest interest to the electrical world. There are few tramways or light railways laid down nowadays which are not intended to be worked by electricity. Further, the profit earned by these undertakings renders the amount paid by them in rates of great importance to the rating authorities, who are not slow to avail themselves of any advantage which the law affords them. The magnitude of the amount paid in rates was made clear by Mr. Bond when he compared the income-tax and rates paid by various companies. Taking a few figures from tramways in all parts of the country, he said that in 1902 Company A paid £313 in income-tax and £1,275 in rates, while Company B (in 1903) paid £166 in income-tax and £447 in rates. It thus appears that a proper rating basis is most important from the point of view of the companies.

In reviewing the present state of the law of rating, as applied to tramways, Mr. Bond draws attention to the fact that the principles applied by the Courts were first enunciated in the days of Elizabeth, and are now to be found in a statute passed so long ago as 1836. The rate is levied "upon an estimate of the net annual value of the several hereditaments rated, that is to say, of the rent at which the same might reasonably be expected to let from year to year, free of all usual tenants' rates and taxes, and tithe commutation rent-charge, if any, and deducting therefrom the probable average annual cost of the repairs, insurance, and other expenses, if any, necessary to maintain them in a state to command such rent." Dealing with the application of this section to tramways and railways, Mr. Bond says:—"But it may be asked: What has all this to do with tramways, railways, and the like? Well, that is the very question I am always asking myself. Such devices of the Evil One were quite unknown to our Sovereign Lady Queen Elizabeth, and no one (not even Mr. Yerkes) has, as yet, offered to take a yearly tenancy of the Great Western Railway. American judges have, I believe, ruled that electricity is a manufactured commodity, and, therefore, liable to import duty; but no English judge, so far as I am aware, has ruled that a tramway is a Brixton villa."

The author of the paper then proceeded to show how that creature of judicial manufacture the "hypothetical tenant" is brought into existence in the case of a tramway, and how the rent which he would probably pay is arrived at by a method of valuation starting from *the profits earned*, and arriving at the annual value of the rateable portion of the undertaking by a series of deductions.

Mr. Bond is not one of those theorists who so often come forward to make loud outcry against an existing evil without suggesting any remedy. He boldly suggests that local rate should be levied, as income-tax is levied, upon the annual profits of a tramway undertaking. In the course of his paper he made the following suggestion:—

"In 1899-1900 nearly £36,000,000 was raised by rates. Let me assume (solely for the sake of illustration) that it was found that one-quarter of this sum was levied from railways, tramways, and the like, and three-quarters from house property and the like. Then let me further assume (again only for the purpose of illustrating my argument) that it was found that an average rate of 4s. in the £ on house property and 1s. in the £ on the income-tax, assessments of the companies would have realised these respective sums of £27,000,000 and £9,000,000. Then Parliament could direct that for the ensuing five years no local authority should impose a higher rate than ¼d. in the £ on the income-tax assessments for every 1d. per £ of rateable value. At the end of every quinquennium these relative poundages might be open to revision by, let me say, the Local Government Board."

This is substantially a proposal to rate a tramway on an entirely new basis, and we confess that we do not think a sufficiently strong case has been made out for such a drastic

change. It is true that the law of rating is one of the most complicated branches of English jurisprudence, but at the same time it has been for many generations uniformly administered by the judges, and the Statute of 1836, however inapplicable it may be to the more modern types of rate-paying property, has been found capable of an interpretation which brings those classes of property into rating. If the principle of rating profits were introduced in the case of an electric tramway, there are a thousand and one classes of property which would have to be rated on the same basis. Take, for instance, the undertaking of an electric lighting company. Their occupation of land by means of cables, wires, &c., is even more fanciful than the occupation of land by a tramway company which has a monopoly of the use of the rails in a street.

We concur, however, in thinking that tramway companies are at present "over-rated." Mr. Bond points out that in his experience the rateable value works out at a little over 20 per cent. of the net profits, as shown in the annual balance-sheet. Having regard to the fact that the local rate in nearly every district shows a tendency to increase rather than diminish, any scheme which can be devised to relieve the tramways would be welcomed by all.

It is sometimes forgotten by those who argue that, inasmuch as tramway companies make large profits, they should be heavily rated, that these bodies are working for the good of the ratepayer, and that both directly and indirectly they do much to relieve the rates. By facilitating the movement of large numbers of working men from one place to another, they assist in solving the housing problem. Again, they are responsible for the repair and maintenance of that portion of the highway which is covered by the track. Mr. Bond has very properly pointed out that, in legislating for light railways, the Government has already recognised this fact. By the Light Railways Act, 1896, it is provided (in effect) that for the purposes of rating, a light railway shall be treated as a railway. The significance of this lies in the fact that by the Public Health Act, 1875, Sec. 211, a railway constructed under the powers of any Act of Parliament for public conveyance, shall be assessed in respect of the same in the proportion of one-fourth part only of the net annual value thereof. This is a distinct advantage conferred upon a light railway, and promoters who are desirous of establishing an electric tramway should consider the advisability of laying a scheme before the Light Railway Commissioners. There is nothing in the existing law to prevent a light railway running where a tramway may be laid. Many of the undertakings now known to the public are really light railways and entitled to the exemption.

Snowed-up.

FORTUNATELY, our climatic conditions, though less to be relied upon than any of the other works of creation, do not often saddle English railways with very serious trouble from the freezing and snowing-up of trains in the winter months; but though the subject may not be of very direct interest in connection with the electrification of our lines, it is worth while relating a recent experience in the States which brought out very clearly one of the advantages following in the train of electrification. From an editorial in New York *Electricity* we learn that, during the first week in January, a heavy fall of snow and zero weather placed practically every steam railroad leading out of New York City in trouble. The freezing of the water in the locomotives and pipes caused delays which disorganised entire traffics, for they had to be thawed out before they could be run into stations and coupled up, angry passengers waiting meanwhile. This state of things may be compared with what was happening on the trolley roads connecting New York and Jersey. While the process of ice melting was proceeding on the steam lines, a few snow plows were able to clear the trolley roads so speedily that all was, so to speak, "plain sailing," and the scheduled times were practically complied with. No matter how cold it became, there was no ice on the motors to require melting.

ON THE CIRCLE-DIAGRAM OF THE REPULSION MOTOR.

Containing a General Method of Deducing the Graphic Theory of any Alternating Current Apparatus.

By F. CREEDY, A.C.G.I.

Preliminary.

As the method to be employed in this article consists of an extension and application to geometry of Mr. Steinmetz's symbolic method, explained in his book, "Alternating Current Phenomena," and now so widely used, it is desirable before starting to say a few words about this method.*

The following notation is employed throughout:—

All vectors are denoted by thick type, such as **e**; versors† by ordinary type, such as z, and numbers by italics, such as *n*.

Thus the magnitude of any complex quantity, **r** is denoted by the same letter in italics, such as *r*.

As is now well known, Mr. Steinmetz expresses a phase diagram in symbols in the following manner:—

He assumes a horizontal and a vertical axis, and resolves all vectors such as R.M.S. currents and E.M.Fs. along these axes.

For instance, **e** being any vector, the horizontal component is represented by a number (say e_1), while the vertical component is distinguished by the prefix $\jmath$ as in $\jmath e_2$. Thus we write (see fig. 1)—

$$\mathbf{e} = e_1 + \jmath e_2.$$

Mr. Steinmetz considers his vectors as the diameters of the circles which represent sine waves in polar co-ordinates.

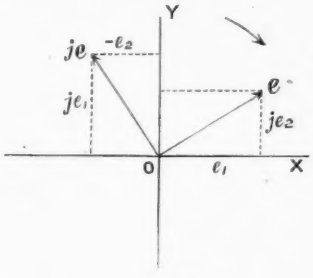


Fig. 1.

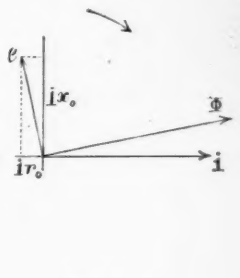


Fig. 2.

Consequently a vector in the position O Y *lags* 90° behind one in the position O X. Thus Steinmetz's diagrams correspond to clock diagrams in which the rotation is clockwise.

A vector of the same length as **e**, but lagging 90°, is represented by $\jmath e_1 - e_2$ (see fig. 1). Now, if we multiply the original vector $e_1 + \jmath e_2$ by $\jmath$ we get $\jmath e_1 + \jmath^2 e_2$. Consequently, defining our prefix $\jmath$ by the equation

$$\jmath^2 = -1, \jmath = \sqrt{-1},$$

we find that multiplying a vector by $\jmath$ retards it by 90° or a quarter period, and that our vectors are represented analytically by complex numbers.

In alternating current theory we have, besides vectors, versors such as impedances, which, when applied to a vector, turn it through a certain angle, and alter its length in a certain ratio. Thus if we have an E.M.F. vector **e**, and the corresponding current vector **i**, and we assume that Ohm's law still applies, we have $\mathbf{e} = \mathbf{i}\,z$, z being impedance. Thus **i** is turned into **e** by the application of z.

In order to find out how to represent z analytically, we may resolve this E.M.F. **e** into two components, one $r\,\mathbf{i}$ in phase with the current and representing the resistance drop, and a second $x\,\mathbf{i}$ ($x = 2\pi n$ L), 90° ahead of the current, required to overcome the counter E.M.F. of self-induction. The latter, accordingly, may be represented by $-\jmath x\,\mathbf{i}$ (since multiplying by $-\jmath$ produces a lead of 90°).

* See also Electrical Review, Vol. 42, pp. 22, 54, 90.

† A name for such quantities as impedances seems to me urgently needed. I use *versor*, a word introduced by Sir W. R. Hamilton and used by him for an operator which alters the direction of a vector without changing its length. I use it for the more general operator which changes the length also.

Therefore, the whole E.M.F. may be represented by the expression $\mathbf{e} = (r - j x)\,\mathbf{i}$, or $z\,\mathbf{i}$.

Thus the E.M.F. consumed by any current is represented symbolically by $\mathbf{i}\,z$, z being the (symbolic) impedance of the circuit in which the current flows.

An important case is that of two mutually inductive circuits, such as occur in alternating current motors. If the circuits contain iron, we have the flux due to the current in any one circuit lagging slightly behind the current.

Thus in fig. 2, let $\mathbf{i}$ be the current in one of the circuits, and ϕ be the flux due to $\mathbf{i}$ common to the two circuits.

Then in the second circuit the flux ϕ will produce an E.M.F., $\mathbf{e}$, lagging 90° behind it, and therefore more than 90° behind $\mathbf{i}$. In terms of the current $\mathbf{i}$, this E.M.F. has two components, $-r_0\,\mathbf{i}$, opposite in phase to the current, and $x_0\,\mathbf{i}$ lagging 90° behind the current.

That is to say, the E.M.F. produced by any current in any circuit not its own, is

$$-(r_0 - j x_0)\,\mathbf{i} = -z_0\,\mathbf{i},$$

where $-r_0\,\mathbf{i}$ is the E.M.F. produced by that component (due to iron losses, &c.), of the common flux, which is in quadrature with the current, and $j x_0\,\mathbf{i}$ is the E.M.F. produced by that component which is in phase with the current. (It is necessary to distinguish clearly between the E.M.F. *consumed* by a current $= \mathbf{i}\,z$, and the E.M.F. *produced* by a current $= -\mathbf{i}\,z$). Since z_0 depends only on the common flux it must be the same for both circuits, if each has the same number of turns.

The reciprocal of this, $Y_0 = \dfrac{1}{z_0}$ is called by Steinmetz the *primary exciting admittance* in the case of alternating current motors.

In its own circuit the current $\mathbf{i}$ consumes, in addition, an E.M.F., $\mathbf{i}\,z = \mathbf{i}\,(r - j x)$, where r is the resistance of the circuit, and x is the reactance due only to those lines which thread no other circuits.

Every vector $\mathbf{a}$ (see fig. 3) may be written—

$a\,(\cos\alpha + j \sin\alpha)$ which may be abbreviated to $a\,\mathrm{cis}\,\alpha$.*

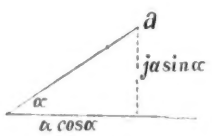


Fig. 3.

Now, by a well-known trigonometrical theorem

$(\cos\alpha + j \sin\alpha) = \varepsilon^{j\alpha}$, and, therefore, $\mathrm{cis}\,\alpha = \varepsilon^{j\alpha}$.

Consequently, by the laws of exponentials,

$$\mathrm{cis}\,\alpha\,\mathrm{cis}\,\beta = \mathrm{cis}\,(\alpha + \beta), \quad \mathrm{cis}\,\alpha/\mathrm{cis}\,\beta = \mathrm{cis}\,\alpha\,\mathrm{cis}\,(-\beta) = \mathrm{cis}\,(\alpha - \beta).$$

Thus, the operator, cis θ, simply turns a vector through the angle θ, counterclockwise or clockwise, according as θ is positive or negative.

Now, let us form the product $\mathbf{e}\,\bar{\mathbf{i}}$, where $\bar{\mathbf{i}}$ denotes the conjugate of $\mathbf{i}$. Thus, if $\mathbf{i} = i_1 + j i_2$, $\bar{\mathbf{i}} = i_1 - j i_2$; or, if $\mathbf{i} = i\,\mathrm{cis}\,\beta$, then $\bar{\mathbf{i}} = i\,\mathrm{cis}\,(-\beta)$.

We have

$$\mathbf{e}\,\bar{\mathbf{i}} = e\,\mathrm{cis}\,\alpha\, i\,\mathrm{cis}\,(-\beta) = e\,i\,\mathrm{cis}\,(\alpha - \beta)$$
$$= e\,i\,(\cos(\alpha - \beta) + j \sin(\alpha - \beta))$$

where $\mathbf{e} = e\,\mathrm{cis}\,\alpha$

$\mathbf{i} = i\,\mathrm{cis}\,\beta$.

Following Steinmetz we may denote the real part of a vector, or product of vectors, by square brackets with the suffix 1 and the imaginary part by square brackets with the suffix j. Thus

$$\mathbf{e}\,\bar{\mathbf{i}} = [\mathbf{e}\,\bar{\mathbf{i}}]_1 + [\mathbf{e}\,\bar{\mathbf{i}}]_j.$$

Now $\bar{\mathbf{e}}\,\mathbf{i} = i\,\mathrm{cis}\,\beta\; e\,\mathrm{cis}\,(-\alpha) = i\,e\,\mathrm{cis}\,(\beta - \alpha)$

$$= e\,i\,(\cos(\alpha - \beta) - j \sin(\alpha - \beta))$$

is the conjugate of $\mathbf{e}\,\bar{\mathbf{i}}$. Thus we have :—

$$\bar{\mathbf{e}}\,\mathbf{i} = [\mathbf{e}\,\bar{\mathbf{i}}]_1 - [\mathbf{e}\,\bar{\mathbf{i}}]_j$$

by the definition of a conjugate. Thus we get the formulæ :—

$$[\mathbf{e}\,\bar{\mathbf{i}}]_1 = [\bar{\mathbf{e}}\,\mathbf{i}]_1, \text{ and } [\mathbf{e}\,\bar{\mathbf{i}}]_j = -[\bar{\mathbf{e}}\,\mathbf{i}]_j.$$

Application to Geometry.—The two functions we have just obtained, viz.: $[\mathbf{e}\,\bar{\mathbf{i}}]_1$ and $[\mathbf{e}\,\bar{\mathbf{i}}]_j$, are of very great importance in geometry. They may be geometrically interpreted as follows :—

We have (see above)

$$[\mathbf{e}\,\bar{\mathbf{i}}]_1 = e\,(i\cos(\alpha - \beta)) = i\,(e\cos(\beta - \alpha)).$$

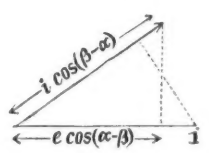


Fig. 4.

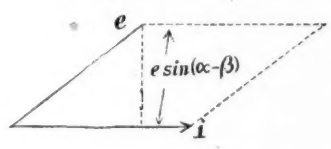


Fig. 5.

Now (see fig. 4) this may be interpreted in the following way :—

$[\mathbf{e}\,\bar{\mathbf{i}}]_1 = [\bar{\mathbf{e}}\,\mathbf{i}]_1$ means *the product of the length of either vector into the projection of the other upon it.*

Treatment of Power by Vectors.—I have not space here to do more than remark that if $\mathbf{i}$ is the current in a circuit and $\mathbf{e}$ the E.M.F. corresponding, the power given to the circuit is $[\mathbf{e}\,\bar{\mathbf{i}}]_1$. I hope to go more fully into this interesting subject at some later date.

We have also (see fig. 5)

$$[\mathbf{e}\,\bar{\mathbf{i}}]_j = +j\,e\,i \sin(\alpha - \beta) = -j\,e\,i \sin(\beta - \alpha).$$

This means *the area of the parallelogram, two of whose sides are* $\mathbf{e}$, $\mathbf{i}$. *Its sign will be positive if* $(\alpha - \beta)$ *is positive, that is, if the least rotation of the barred vector, which would make it parallel to the unbarred vector, is counterclockwise,* $[\mathbf{e}\,\bar{\mathbf{i}}]_j$ *is positive.*

It should be noted that the above should be considered as functions of $\mathbf{e}$ and $\mathbf{i}$, not of $\mathbf{e}$ and $\bar{\mathbf{i}}$.

It is now possible to show how this method renders easy the deduction of all possible graphic theories of any alternating current apparatus (whose action does not require more than two independent variables for its complete specification) from its fundamental symbolic equations. In order to show this, the method will be applied in the first instance to the repulsion motor.

(To be continued.)

* See Am. Inst. El. Eng, Vol. 16., p. 322. This notation, introduced by Mr. Jackson, has the advantage of bringing the angle α into more prominence than the notation $\varepsilon^{j\alpha}$ does.

A STEAM METER.

By R. S. BAYNTUN.

The object of this invention, which has recently been brought out by the writer and Mr. W. J. Bamber, two of the engineering staff at the Bloom Street and Dickinson Street works of the Manchester Corporation Electricity Department, is to measure and record the weight or quantity of

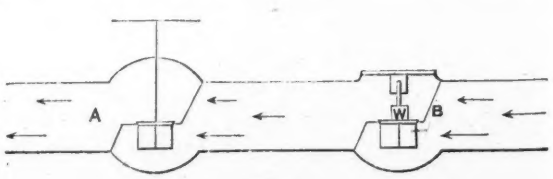


Fig. 1.

steam passing through a pipe. By its means, the rate at which a boiler is raising, or an engine using, steam, may be read directly off a scale, and, by the addition of a recording drum, a continuous record may be kept, from which the total weight passed in any given time may be ascertained.

The principle of its working is very simple. Suppose that in fig. 1 steam is in the pipe A B, supplied from the end B, and that the end A is connected to any steam-using apparatus.

Let A represent an ordinary stop valve regulating the supply of steam, and B a check valve loaded with a small weight, and suitably guided to rise and fall without sticking. Then, if the valve A be closed, no steam can pass, and valve B will obviously remain shut by its weight. Now suppose that A be opened slightly, any steam in the pipe between A and B will escape, and the unbalanced steam pressure on the under side of B will instantly cause it to lift and open.

To investigate the extent of its lift, suppose, in the first place, that this should be sufficient to cause its opening to be so great that the valve does not throttle to the extent due to its weight, say 2 oz. per sq. in.; then there would be nothing to support it in that position, and it would close again till its area of opening was that due to throttle given.

Next suppose it to open to an insufficient extent, so that it throttles too much. Then the unbalanced pressure will open it more until its opening is correct as before.

It is thus in perfect equilibrium at this point; it cannot close more, as this would cause an unbalanced pressure which would open it again; and it cannot open more, as there would be nothing to support the weight, which would close by gravity. The effect of the impact of the steam is quite negligible, as a simple calculation will show.

If now the valve A be opened a little, the unbalanced pressure will at once open B correspondingly, and should valve A be partially closed, B will in like measure be closed by gravity.

Then if the opening of A remain constant, and all the conditions as regards pressure, &c., also remain constant, the rate at which steam is passing will also remain constant, and if the opening be changed the steam passing will also be changed in like proportion.

To look at the action of B in another way, we may say that it is always on the point of throttling, though not in the ordinary way, since it always throttles to a constant extent, due to the weight, of a few ounces per square inch, and it is impossible for that degree of throttling to vary. Also it has been found, by experiment, that, *given a constant throttle, the rate at which steam flows is proportional to the opening*, the pressure being constant. This is the essential principle of the meter's working.

Thus the opening or lift of B is an exact measure of the rate of flow of steam, and it is only necessary to transmit the motion of this lift to the exterior of the valve, that it may be registered on a suitable scale or recording drum, and we have a complete steam meter.

To gauge the lift, the valve in rising is caused to turn a spindle, an extension of which, suitably packed to minimise

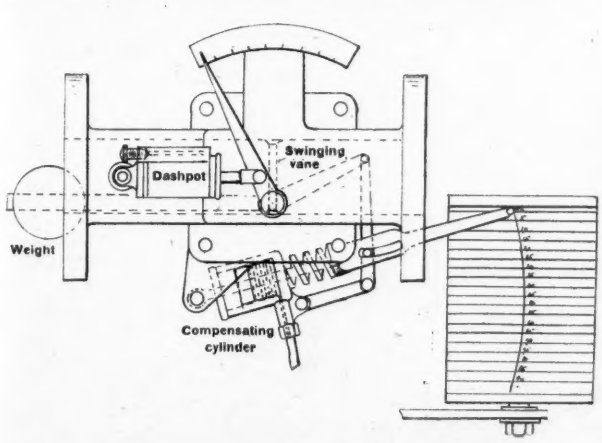


Fig. 2.

friction, is brought through the side of the casing. A pointer is attached to this and registers the reading on a scale evenly divided to represent lbs. of steam passing per hour.

The weight used is but small, being of such a magnitude as to close the valve against the friction of the moving parts. In many cases the weight of the clack alone is sufficient for the purpose.

A dashpot is used in some cases to damp the sudden movements of the valve due to rapid fluctuations of the amount of steam passing. The valve is also fitted with a

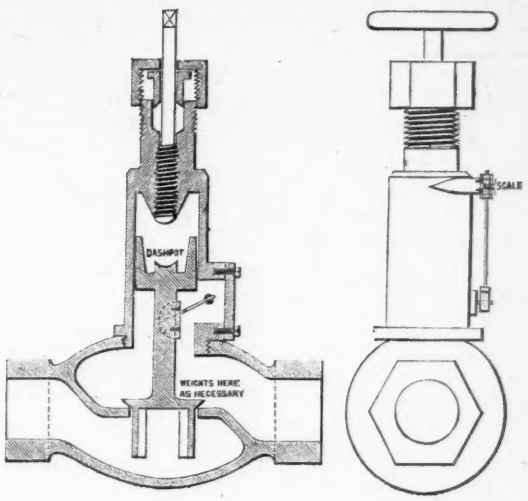


Fig. 3.

wheel and spindle for use as an ordinary stop valve when desired.

It will have been gathered from the above that the meter is essentially a volume meter, and as the volume per lb. of steam varies with the pressure, if this is likely to vary much in the same meter, it is necessary to use a device for compensating this error.

A simple one has been designed in which the motion of the valve is transmitted to the scale, through a lever, the

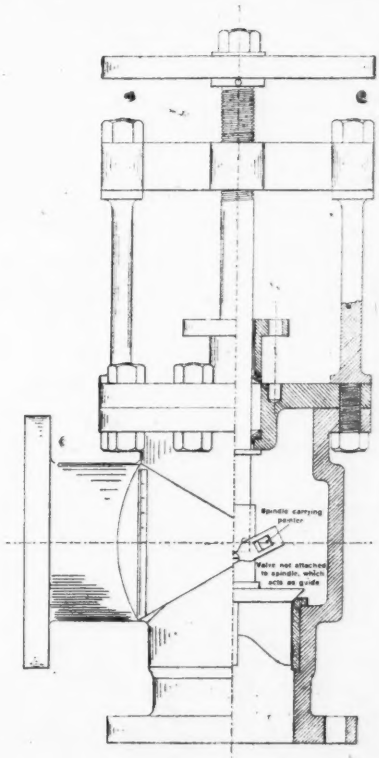


Fig. 4.

fulcrum of which is movable, by a suitable form of pressure gauge.

Thus, if the steam pressure should alter, and consequently the amount of steam passing, for a given opening of valve, the relative lengths of the arms of the pointer lever will vary so as to give different readings for the same lift of valve.

D

Fig. 2 shows a form of the meter in which a swinging vane is used, and the weight, or an equivalent spring tending to close the valve, and the dashpot, are all external to the casing. It is shown as a recording meter.

Fig. 3 shows a valve of the standard type, as adapted to small sizes; the meter is shown complete with dashpot and stop valve attachment.

Fig. 4 shows how a junction valve of the usual mushroom type may be adapted to form a steam meter. From this figure it will be seen how slight are the changes, the leading dimensions lending themselves admirably to the arrangement.

The uses to which the meter may be put are very many.

There has hitherto been no method of ascertaining the amount of steam generated by a boiler or used by an engine, but the clumsy and unreliable one of measuring the feed water, or if surface condensers be in use of measuring the water by condensation.

Neither of these methods taking into account the wetness of the steam, elaborate tests have to be made with one or other of the various types of calorimeter, all of which require considerable skill and care in use, and not one of which is really reliable even then. Also the steam test must be of at least six hours' duration, to eliminate as far as possible errors of measurement.

In short, a boiler evaporation or engine steam consumption test is a matter requiring much skill in carrying out, and causing much trouble and expense by reason of the elaborate preparations required. As a matter of fact, tests have generally to be made at the week end, to avoid interfering with the ordinary running of the plant.

On the other hand, with a steam meter, readings can be regularly taken without any preparation, and entered in the log, or the recording sheets can be filed.

The meter measures only the steam passing and not the water, as it is a volume meter, and the volume of steam is several hundred times that of an equal weight of water. It is the acme of simplicity, has nothing in it to go wrong, and should cost in the simple form little more than a stop valve, which it is eminently fitted to replace.

For use in this form as a junction valve fitted to each of a range of boilers, its readings should be of great value, showing at once any failure in the steaming capacity of any boiler, whether due to scaling, to dirty flues and tubes, or to unskilled firing, and in the event of hard steaming showing at a glance which of the boilers are not doing their share of the work.

With a steam meter the economies of engines at various loads can most conveniently be noted, and any increase in consumption due to leakage or other causes would very soon be noticed.

It would seem probable that with the greatly increased facilities the meter affords for testing, records will be kept in a manner hitherto impossible, which, by increasing the knowledge available of the working and economy of steam plants, will serve to further their progress.

The meter has other uses, to which we can allude but briefly, such as for where steam is used for industrial purposes, and where it is sold in bulk, as is so largely the case in the States.

The writer may conclude by stating that since its inception some twelve months ago, the invention has been thoroughly tested with most satisfactory results, it having proved a perfect steam meter. The instrument has been patented, and Mr. W. J. Bamber has acquired the patent rights.

TECHNICAL EDUCATION: THE PAY OF THE PROFESSOR.

By A UNIVERSITY LECTURER.

Recently Dr. Rhodes made a most admirable suggestion in the columns of this journal—that manufacturers should select certain promising students at technical colleges for employment during vacations, and finally for a permanent position on the works' staff. Simultaneously Prof. Silvanus P. Thompson was waging war with the District Council of Erith for advertising for premium pupils at £50 per annum. In short, the question which is troubling many of us in the teaching line is one concerning the premium pupil, and it may be stated as: "Is the premium system doomed?"

Probably the original idea of the premium system was that, through it, a man paid his footing into his profession. It gave him a certain status. But the most enterprising manufacturers quickly discovered that the system was a great burden to them; not only did the "premiums" refuse to do any work themselves, but they were an almost intolerable nuisance in the works. Of course, there were exceptions. In the testing department of a large engineering works the author had several "premiums" under him; it is almost certain that, on the average, they were no better, no worse than those in other works. Two of them were fully worth £1 a week to the firm, although they themselves had each paid £100 down for the privilege of a year's experience. But the others. They wanted to pick their jobs; they wanted to come late and go away early; they fairly made the workmen with whom they came in contact bristle with indignation at their monkey tricks. They were an intolerable nuisance, because they had to be watched. That firm now refuses to take "premiums," and comparative peace and quietness has been the reward. It takes improvers and apprentices, all of them "six o'clock men," the former liable to instant dismissal.

Let us, therefore, acting upon this experience, assume that the "premium system" for the purposes of teaching the profession of electrical engineering is a failure. How shall it be replaced? Here, again, Dr. Rhodes helps us. Obtain teachers qualified to act in co-operation with the manufacturers; obtain the best brains at any cost, and do not drive the professor into consulting work as a means of livelihood. Nobody objects to a *little* consulting work being done; it keeps the professor in touch with everyday practice, and prevents him becoming, as his brother at Oxford, cut adrift from the stream of life. He should be, first and foremost, a teacher of engineering; after that, a man to be consulted on engineering work. Many in the teaching profession give their half-a-dozen lectures a week, leave the whole of the administrative and laboratory work to their underpaid assistants, and devote most of their time to external work. And no wonder. If they did not do so, it would not be worth their while to remain in the teaching profession. Only a few weeks ago there was a striking advertisement in the technical papers. A large engineering firm required a manager at £3,000 a year. He was to devote the whole of his time to the work. Can it be expected that the many professors paid below £1,000 a year will devote the whole of the time to *their* work—or even most of their time to their professorial duties?

When the question of salaries is raised, the defence of all Councils, Senates and Committees may be boiled down in a brief sentence. "We are too poor," they say; very well, let them increase their fees. The premium pupil paid for his footing, the doctor or the barrister requires a certain capital expenditure before he can enter his profession. His teachers are paid well. Therefore increase the fees of the technical students in our colleges, but, for the sake of the underpaid professor and his assistants, ear-mark that money for their benefit. There is one place, at least, where the fees obtained from the technical students support a dear old past-century professor, who loves to tell us poor technical men that we are spoiling the pleasures of life by making this an age of bustle and rush. He lives among his old Latin and Greek heroes, admirable acquaintances (provided the acquaintance be superficial), but, to the practical man, cold companions; but my dear old dusty professor of Latin, who despises "tuppenny tubes," and hates even the electric motor-car, *he* gets paid double the salary of his over-worked colleague, who trains treble the number of students in electrical engineering. And the Latin man, should you show him the injustice of the case, replies: "Yes, but you engineers make so much by outside work." Poor old fellow, he only tried outside work once—it was a Latin grammar, I think, and the sale of it was like his energy—limited.

Consequently, the great problem of technical education is solved, to a very great extent, if the teachers are to be paid better. They must be able to concentrate the whole of their energy upon their teaching duties. They must be able to live on their salary. Preferably, they should be very human. They should cultivate, not shun, the acquaintance of manufacturers. If possible, the technical department of a

university, or large college, should be under completely separate management, and run on its own merits. In many cases, what is wanted is money for paying the staff properly and founding scholarships. Bleed the rich student, even as do the older seats of learning, but give the poor one every chance. Direct the great stream of money—most of it now being wasted—which is used for evening technical schools, along channels leading to pastures which pay for the cultivation. Use this money for founding scholarships. Dr. Rhodes repeats what has long been patent to those who have had to do with evening classes—they are wearisome to the flesh. And yet our worthy city and borough councillors think that this is the only kind of technical education needed.

The whole question seems to be one of money. We all agree that State aid is needed badly. In many places the local rates might be used to subsidise day classes for instruction. Higher fees should be charged to the student who can afford to pay them, and scholarships founded for those who would otherwise not get a chance. Above all, the salaries of the teaching staff should be such that they are not tempted to go into another position. Concerning the teachers themselves—it is a very dangerous subject. In many cases it should be insisted that they too have the "sandwich" system, and spend a portion of their year in a works. Unfortunately the junior men are usually so overworked that even their vacations are full up with college work, and so technical education suffers and the country suffers. Why not appoint a Royal Commission to report and take evidence upon this subject? C. A. S.

CONDUCTIVITY OF MERCURY VAPOUR.

Mr. Peter Cooper Hewitt, whose name is so well known in connection with the electric mercury vapour lamp, contributes an article of no small interest to the *Electrical World and Engineer*, New York, for December 19th last. The article deals mainly with the electrical data connected with the conductivity of mercury vapour under different conditions of vapour density, of current strength, and of the diameter of the containing vessel; and with a description of a cleverly designed apparatus, which had been constructed to obtain the data.

The apparatus consisted of a closed chamber of heat-insulating material, inside which the temperature of the air could be varied at will by passing a current through a resistance heating coil, controlled by an external rheostat. By means of a fan, the enclosed air could be maintained in rapid circulation. In the air chamber, but out of direct radiation from the resistance heater, was suspended the tube, or lamp, containing mercury vapour, near which thermometers were inserted to indicate the temperature of the air surrounding the tube. The respective tubes to be operated on were fitted with two platinum-rhodium thermo-couples, sealed into the glass at a definite distance apart, and placed as far as possible from the + and — poles of the lamp, so as to be out of the disturbing influence of the positive and negative electrodes. "The external terminals of these couples were immersed in ice and connected to a d'Arsonval galvanometer. The internal temperature was measured by means of these couples by observing the deflection of the galvanometer. It was possible to ascertain accurately when the internal and external temperatures were the same. The drop in volts between the platinum-rhodium points was taken by a Kelvin electrostatic voltmeter, the couples thus serving a double purpose. It was possible to obtain voltage measurements at the temperatures desired. When a required temperature was obtained internally and externally, the current was started through the lamp by the starting device, and was controlled by an external resistance, and measured by a Weston ammeter. Immediately after starting the current, the reading of the Kelvin voltmeter was taken. There was sufficient time to obtain these readings accurately before the current materially altered the vapour density."

Particular care had to be exercised in obtaining nothing but pure mercury, as the presence of any foreign gas or vapour greatly vitiates the results. In most cases the experiments were repeated many times to verify the data. The vapour density was varied by maintaining the tube at different temperatures to produce the required pressure.

As a result of the observations it was found that the most important factors bearing on the efficiency of the lamp are those of current strength and of vapour density, and we therefore reproduce the curves illustrating the effect of these conditions in tubes of different diameters. From these and two other "observed" curves showing "the relation of drop in volts per cm. of length to the pressure in mm. of mercury for different diameters at constant current," the investigators have deduced others styled derived curves. These show:—

(*a*) "Derived curves showing the relation between voltage drop per cm. to the current in amperes for different pressures of mercury vapour.

(*b*) "Derived curves showing the relation of resistances per cm.; voltage drop per cm.; and watts absorbed per cm. to the diameter of the tube in cm. for different pressures of mercury vapour.

(*c*) "Derived curves showing the relation between watts absorbed per cm. of length to current in amperes for different pressures of mercury.

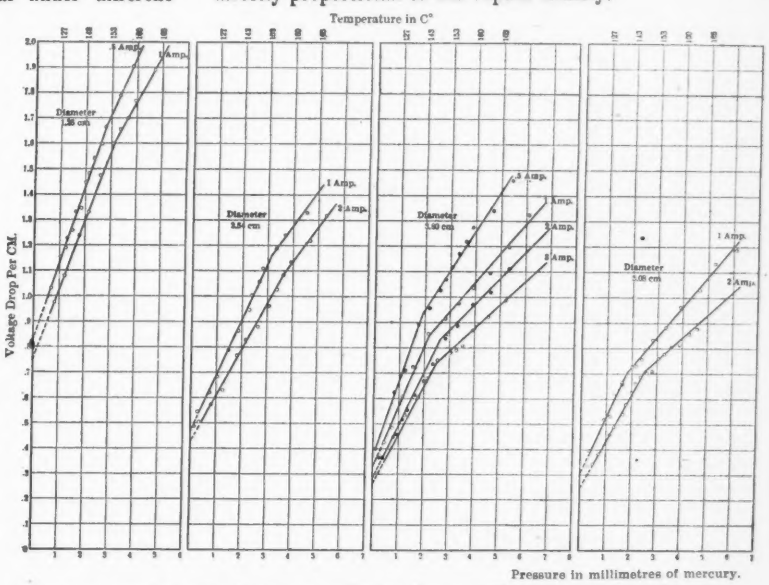
(*d*) "Derived curves showing the relation of current in amperes to the resistance in ohms per cm. of length for different pressures of mercury vapour."

For these curves we must refer those specially interested to the original article.

A study of the curves discloses, amongst others, the following facts:—

1. The voltage required to maintain a given current decreases as the diameter of the tube is increased.

2. The voltage required to maintain a given current is directly proportional to the vapour density.



Diagrams showing the Relation between Drop in Volts per cm. of Length and the Pressure in mm. of Mercury.

3. The resistance of the vapour decreases as the current strength is increased.

With regard to the apparent manner in which the vapour of mercury conducts electricity, Mr. Hewitt makes the following interesting remarks:—"The current assumes a definite cross-section for a given density and current when not restricted by the lamp; this cross-section increases with increase of current, and decreases with increase of density. The angles in the curves shown may be due to these effects, but this point needs further investigation."

The light efficiency of the lamp varies with the vapour density of the mercury. With a low pressure, very little

light is emitted, but as it is increased the efficiency is increased to a certain point, and then decreases. If another gas is present with the mercury vapour, the current is usually selective, and gives the spectrum of mercury vapour, but the resistance is materially altered, though whether raised or lowered is not stated. The effect of magnetic force, applied transversely, is both striking and important. The resistance becomes markedly increased, especially at low vapour densities, whilst the spectrum is markedly changed. The conclusions which may be drawn with respect to the relation of the conductivity of mercury vapour to the physical conditions under which the electrical current through the vapour is maintained, appear to be, broadly speaking, generally true for all gases and vapours.

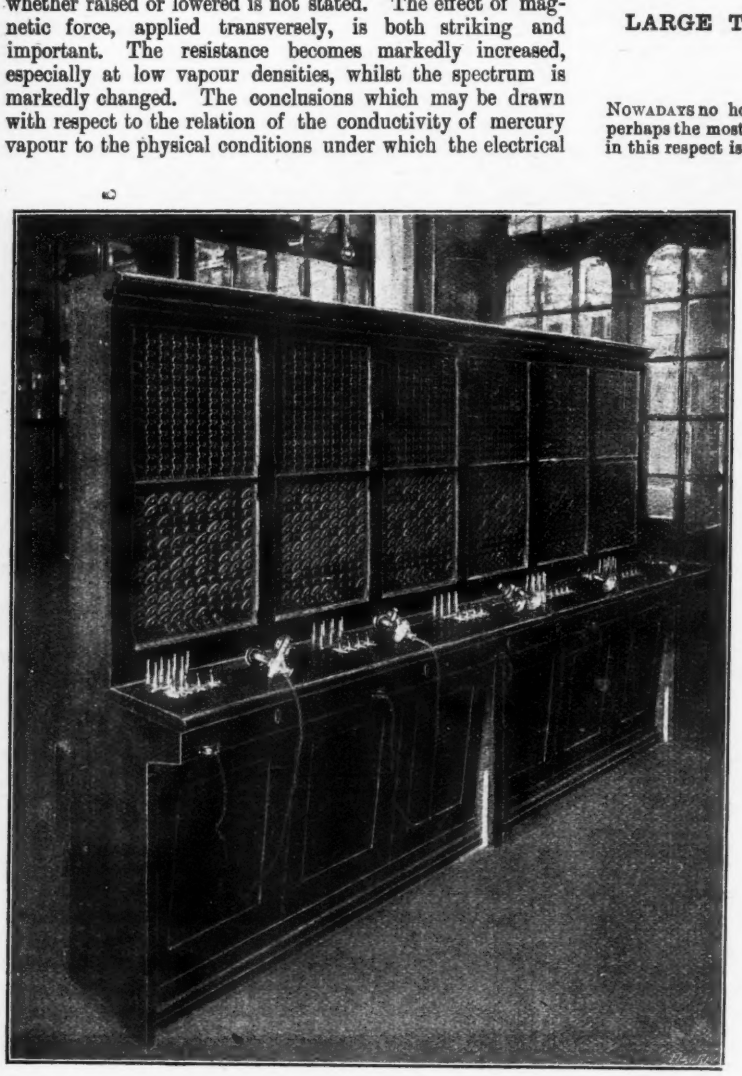
The important conclusion to be drawn from the observations as regards the utility of the lamp is, that "the highest light efficiency will be obtained when the vapour density and the current employed have a definite and fixed relation."

In a note commenting on Mr. Hewitt's article, our contemporary makes a remark which is not strictly in accordance with fact, in the following somewhat mysteriously worded sentence:—"One curious fact in connection with vapour conduction is that Ohm's law is applicable notwithstanding that for fixed conditions the voltage is constant, the anomaly being due to the fact that the resistance decreases as the current increases, this being directly contrary to the case of electrical conduction in solids." What is presumably intended to be understood is that with an increased (not constant) voltage a decrease of resistance and an increase of current occurs as a result of a higher temperature. This result is, however, by no means universally the reverse of what occurs in the conductivity of solids. With metals the statement is, of course, substantially true, but it is certainly not so in the case of the carbon filament, and still less is it the case with other solid bodies, such as the Nernst glower.

We are pleased to note that Mr. Hewitt informs us that, in the near future, Dr. A. P. Wills, who has ably assisted him in carrying on his investigations, intends to publish a more detailed account of the methods and apparatus employed.

LARGE TELEPHONE INSTALLATION IN AN HOTEL.

Nowadays no hotel is complete without a telephone installation, and perhaps the most up-to-date hotel in London, if not in this country, in this respect is St. Ermin's Hotel, Westminster, where a 600-line switchboard has recently been erected, with which is connected practically every room in the house. Not only have telephones been fitted in all the bed and living rooms but also in each of the departments, enabling the guests to give their orders direct to the various offices. The convenience thus afforded to visitors must be inestimable, for not only are they able to communicate with the hotel officials, but it can readily be ascertained whether they are in their rooms or no, in the event of friends calling; by this means also the servants' journeys up and down stairs must be considerably reduced.



St. Ermin's Hotel: Six-section Telephone Switchboard.

Telephone Set.

The instruments are of the most up to-date pattern, comprising the hand combination set on a long flexible cord, by means of which visitors can speak and give their orders without getting out of bed; we give herewith an illustration of the telephone.

The switchboard, which we also illustrate, was specially manufactured for this installation by the Western Electric Co., of Queen Victoria Street and Woolwich, and is made up of six sections, each of which corresponds to a floor in the hotel.

At certain times of the day six operators are able to work at one time, there being an operator's outfit supplied for each section, and with a view to facilitate the work, all the "service" stations are multipled on each section.

The work has been carried out by the Private Wire and Telephone Installation Co., Ltd., Westminster, S.W., who specially lay themselves out for installation work in all large premises where intercommunication is desired.

THE VOGT GAS ENGINE.*

To have devised and constructed a gas engine of only 1¾ H.P. which consumes the same volume of town gas per I.H.P.-hr. as an engine of 200 H.P. (16 to 18 cb. ft.) is an accomplishment worthy of notice, and it is said that an engine of 1,000 H.P. is to be built to confirm the advantages indicated by this small engine.

The chief peculiarities of Mr. Vogt's invention may briefly be described as follows:—

In its smallest unit it requires two chambers joined by a cylindrical connection, in which reciprocates the piston; and the most striking difference between this engine and others is that, instead of being furnished with a water jacket, the water is inside the cylinder and combustion chambers, surrounding the reciprocating piston and moving with it in and out of the combustion chambers.

* "The Vogt Gas Engine." By Herbert A. Humphrey, M.Inst.C.E. *Engineering*, January 8th, 1904.

By this arrangement the inventor is enabled to obtain a constant compression pressure, whatever the volume and power of the explosive charge. Further advantages are that owing to the piston being surrounded by water, it is never subjected to intense heat, and the valves do not require water cooling internally, as the water in the cylinder passes over most of them. To quote Mr. Humphrey: "An engine that gives in one cylinder (two combustion chambers) two impulses per revolution, that explodes its gaseous mixture in contact with water, that has no water jacket or externally-cooled valves, that gives always the same quality of mixture and the same compression for all loads, and, finally, has its greatest efficiency at normal working load, rather than at full load, is worth careful examination." The particulars given by Mr. Humphrey, of the special points included in the inventor's endeavours to produce a practical engine of high efficiency, will, with the results obtained from an engine of such small power, lead us to await with interest the building of one of a reasonably high power.

The piston speed of the small model was only about 100 ft. per minute, and if the larger engine which is to be built is found to be capable of giving a piston speed of from 800 ft. to 900 ft. per minute, the success of the inventor's new type of engine will be assured.

CORRESPONDENCE.

Letters received after first post on Wednesday morning cannot appear until the following week.

Wages of Switchboard Attendants.

In your issue of the 29th ult., you make reference to letters on the subject of the disquiet of a switchboard attendant, on account of his small wage, when compared with that of an engine driver.

Perhaps these points may not have come to his notice :—

1. Ordinarily he is quite a young person, generally fresh from pupilage ; the driver, on the other hand, is, as a rule, a mature man, both in years and in his departmental work.

2. The switchboard attendant having arrived at that stage of evolution, should not look at it as the apex of his career ; it is a stage of his experience, and as he is only qualifying to become an engineer, he cannot expect to earn experienced men's money. The driver but seldom rises to the broader engineering work, on account of his early training, but as an expert in his line is paid accordingly.

3. There are hundreds of young aspirants for the engineering honours who are content to consider the early stages practically tuition, and who trust, by their exertion and ability, to rise to salaries many times greater than that of the envied driver.

A Whilom Switchboard Attendant.

The Bristol Fire and its Lessons.

Those engineers who remember what a high-tension switchboard was like before the introduction of the Ferranti single-pole cellular board will be thankful that the serious calamity at Bristol, referred to in Mr. Clothier's recent report, did not occur before the now generally recognised merits of this board were fully established. The system has been introduced into so many stations, and there have been so few breakdowns of a really serious nature, that it has been considered by many to be the acme of safety, simplicity and reliability, and those of us who have expressed the opinion that there were some weak points in the design have been considered pessimistic faddists. There can now, however, be no doubt that very serious dangers do exist, and, although it may be several years before another such outbreak occurs, those engineers who are responsible for systems similarly equipped are bound to realise their danger. That this is so is evident from the fact that from all parts of the country we hear of steps being taken to prevent such another catastrophe.

We must all admire the way Mr. Clothier has, in his report upon the breakdown, endeavoured to face and efficiently tackle the problem, instead of attempting to belittle and hush the matter up, as he might well have been excused for doing.

It is not my intention to say much about the general design of switchgear, but rather to confine my remarks to one or two paragraphs in Mr. Clothier's reports respecting the use of protecting devices. I will, however, take this opportunity of expressing the opinion that the general principle of cellular construction is undoubtedly right, but to be sufficiently safe it must be carried much further than in the present standard Ferranti board. The divisions between the cells must be capable of resisting the attack of the severest arc imaginable.

The weakest feature of the present design is the cramping together of all the H.T. connections into so small a compass, with the result that an arc having been once started, more or less complete destruction of the board followed as a natural consequence. The advantages of compact control are, of course, obvious ; but, although the operating gear may be confined to a small space, it should, I think, be arranged to control switches placed at a distance from each other and from the operating gear.

It is evident, from the published reports of the Bristol breakdown, that the origin of the trouble was the failure of one or more generator fuses. Whether the blowing of the fuse was due to a fault on a generator, to a loose connection in the fuse, or to mere deterioration of the fuse wire, will probably never be known. The one thing apparent is that, if fuses had not been used in the generator circuits, the trouble would not have occurred.

It is now nearly 12 years since Mr. Raworth first pointed out the danger of using fuses in the generator circuits. Since that time the danger has been repeatedly referred to by different writers, and only a few weeks ago Mr. Eborall, in his interesting series of articles in *Engineering* on "Switchgear," again drew attention to it.

The question now arises as to whether, if fuses are done away with, it is necessary to replace them by any other device. It is argued against such replacement that an attendant must be kept on the board, and he can instantly operate the switch controlling any generator that shows signs of failing. If the fault on the generator is a breakdown to earth, the noise and fireworks accompanying the failure will doubtless be ample indication as to which machine it is that is running amuck. But a generator may fail in several ways without giving any such visual or aural indication that it is behaving abnormally.

What, for instance, is more likely to occur than the interruption or short-circuit of the field current of the exciter of a separately excited alternator connected in parallel with others ? This alternator, of course, becomes a short-circuit on the bus-bars, and the first notification the switchboard attendant has of the trouble is a general drop of pressure across the main bus-bars. He immediately looks at his ammeters to see the cause. The ammeter of the faulty machine will be hard over because of the short-circuit current passing through it, but the ammeters of the healthy generators are now carrying the whole of the outside load, in addition to the short-circuit current feeding the faulty generator, and as a consequence these ammeters will also be hard over. The pressure continues to fall, and the attendant looks anxiously at the generators for some further indication to guide him in his operations. To his great relief he sees one of the generators smoking, and instantly switches it out, reasonably imagining that it is the faulty generator. He finds, however, to his horror, that he has switched out one of the healthy machines that was doing more than its share of the work, and the burden upon the others is in consequence enormously increased. Nothing can now save the situation but a complete shut-down, and a fresh start, with all the delay of re-paralleling and switching on of feeder sections one by one.

The next point to be considered is, should the discriminating device be used merely as a current direction indicator and the actual switching operations be left to the attendant, or should it be used to operate an automatic circuit-breaker ? It is probable that the radical alterations necessary to equip the majority of existing switchboards with automatic circuit-breakers will deter engineers from considering the latter alternative. Where, however, new boards are being erected there is much to be said in favour of installing reverse current circuit-breakers, as is being done on the Continent and in the United States.

As Mr. Clothier explains, alternating current discriminating cut-outs can be relied upon to effectually isolate any fault, except a low resistance short circuit across the generator leads, but he should have added that under these very exceptional conditions the cut-out will not introduce any further elements of risk ; it will merely remain inoperative and the conditions will be the same as if the cut-out had not been installed—that is to say, it will be necessary to depend upon hand operation only. In the event of any other fault

occurring, such as a failure of the generator field, a breakdown of the engine, or the flashing to pole-pieces of the armature, the cut-out will behave as required. If these cut-outs are made to operate on a reverse current of not less than 30 per cent. of the full load current, it is not necessary to cut them out of action during synchronising operation.

Mr. Clothier suggests that if a discriminating cut-out possesses some time element it is no better than a fuse, in respect to the instantaneous isolation of the fault. This, however, is not the point. As he himself shows earlier in his report, the use of fuses on generator circuits is theoretically wrong, *because the fuses on the healthy generators are liable to blow before the fuse on the faulty generator*. That this does not always happen merely shows that fuses cannot be relied upon to always blow at the current they are set for. There is, however, another point in favour of automatically operated cut-outs as compared with fuses. The blowing of a fuse is bound to volatilise a considerable quantity of metal and this forms a highly conducting vapour, which tends to maintain the arc. Although in many modern fuses this arc is, in the majority of cases, effectually extinguished, it is doubtful whether any design of fuse has yet been introduced that can be relied upon to do so under all conditions. Now in a properly designed oil circuit breaker, no metal is volatilised, and no arc is formed.

I do not wish to convey the idea that the design of a reliable discriminating cut-out for alternating currents is by any means a simple matter. I have closely studied the behaviour of these interesting devices under actual working conditions for over nine years, and have at times almost despaired of surmounting all of the many difficulties that have from time to time arisen. The actual conditions under which these cut-outs have been tried include short-circuits on feeders, failures of engines, open circuits in field windings, &c. By investigating the respective conditions by the aid of a Duddell oscillograph we have been able to so modify the design of our cut-out release as to ensure its working under all conditions except that of a dead short across the generator leads.

The conclusions we may come to may be briefly summarised as follows :—

Alternating current discriminating cut-outs cannot be relied upon to isolate a low resistance fault on generator leads or on duplicate feeders.

A cut-out that will isolate a generator, should it lose its field, may fail to isolate a generator, the engine of which has broken down, or *vice versâ*, unless the cut-out is specially designed to deal with both conditions.

Some types of discriminating cut-outs will operate on a heavy forward current, and are in consequence no better than fuses.

Some cut-outs that will operate on a small reverse current will fail to do so on a heavy reverse, or *vice versâ*.

Alternating current discriminating cut-outs can be made that will under no conditions cut off a generator so long as it continues to supply current to the bus-bars, but will isolate a failing machine immediately it tends to short-circuit the bus-bars, whether the failure be due to a broken down engine, a loss of excitation, or to an earth in the armature, provided such earth is not a very low resistance fault on the terminal connected to an unearthed bus-bar.

It is an interesting fact that so long as the supply was kept on at Bristol, the pressure across the bus-bars did not fall below 60 per cent. of normal pressure, although the bus-bars were the whole time short-circuited by a most destructive arc.

Leonard Andrews.

Faraday House "Appointments."

It is now the proud boast of the Electrical Standardising, Testing and Training Institution that "appointments" are found for *all* their students. Only a Faraday House man can fully understand the absurdity of such a statement. What are these so-called "appointments"? The Faraday House course which, by the way, is an excellent one, costs the student on an average about £500, including cost of living, when going through this training. After spending this sum of money, 80 per cent. of the students have "appointments" found for them at the enormous salaries of from 10s. to 20s. per week! The remaining 20 per cent. are, of course, the very clever men, and men with influence, such as, let us say, town councillors' sons and relations.

Now, take a youth in a provincial town who pays £50 a year for two years. For this £100 he goes through the electricity works of his town. How is it then that these men can compete with Faraday House men? Of course, nothing can keep a smart man in the background, however poor his training may be, and *vice versâ*, but leaving this out of the question, it is a fact, and a well-known fact, that men dragged through an electric light station can start at the same salary and on the same footing with an expensively and carefully "trained" Faradian. This state of affairs is partly due to the Faraday House authorities, who, as soon as a man is out of his time, push him into anything.

This is the only disingenuous part about the Faraday House course. In this way they encourage stations which are worked on a system that would make a Hebrew tailor blush; some of these stations are nothing more or less than sweating shops, and Faraday House, instead of holding out for decent salaries, feeds these sweating shops with highly-trained, but unfortunate, students. Of course, these students must gain experience and self-reliance; but surely they are worth 30s. a week? If not, how did they pass the entrance examination to Faraday House, and how did they pass through the Institution?

An Old Faradian.

A Question of Vibration.

Why should a motor-generator, or booster, or rotary converter, rock the building it is fixed in?

Before erection, I said it couldn't, because all the parts were balanced; and now it is working it does rock the buildings considerably, and is causing much annoyance. I am being laughed at as another instance of "theory *v.* practice."

But why should they rock (only continuous HV to LV used)?

Puzzled.

[The vibration is due to faulty practice, not to mistaken theory. There ought to be no vibration, and the presence of the latter shows that the rotating parts are not balanced as they should be. If the want of balance cannot be remedied, the motor-generator must be supported on springs —possibly thick rubber pads would suffice.—Eds. E.R.]

Electric Shocks on Flat-Back Switchboards.

As I have often been in the station where the accident referred to recently by Mr. Heppenstall took place, I was naturally interested in Mr. Guthrie's reply. It seems rather late in the day for the latter to complain, for he would surely have been justified in refusing to work with faulty appliances, taking into consideration the extremely high voltage involved; but then I should imagine that it would be extremely difficult to inspire caution in a man who could "remember" how long he was "unconscious," as stated in his recent letter.

F. B.

January 27th, 1904.

Packing.

Referring to the letter signed "M.I.E.E." in your issue of December 18th last, I should like to add that in India we all suffer from this same cause of complaint. A most interesting paper on the subject, by Mr. Brühl, was read last year before the Calcutta Section of the I.E.E., and reprinted in the technical Press at home (Electrical Review, August 21st, 1903). It may be noted, however, that English manufacturers *can* pack most excellently at times; this is especially noticeable when the apparatus has been once received broken up, and then returned to the makers! When practicable your correspondent should try this.

X. Y. Z.

Calcutta.

The Education of an Electrical Engineer.

The writer has followed with much interest the correspondence appearing in your recent issues, called forth by the advertisements of two educational institutions seeking in-

structors. As president of one of the institutions referred to, the writer, for obvious reasons, has kept aloof from the discussion ; nor, in what follows, does he care to enter into the question of the remuneration of technical instructors, important though this subject may be. That is a matter in which every educational institution must work out its own salvation, and which must, of course, depend largely on the funds available for the purpose.

What prompts me more particularly to ask a little of your space is a remark contained in the letter signed "Arrowroot," appearing in your issue of January 29th, in which that writer, referring to a certain correspondence school, states that its instructors will be found to compare favourably with those of any other college staff. This is as it should be, and the correspondence school that skimps either in the quality or number of its tutors will soon find itself without students; for there is none keener than the ambitious correspondence student, who may be depended upon to be heard from if he imagines himself neglected in the slightest degree. These students, it must be borne in mind, are paying for their instruction out of their own pockets, and that makes all the difference in the world.

But the point I wish to bring out is this, while the best instructors are none too good for a correspondence college, and, indeed, their employment is absolutely necessary with that method of instruction, their function is, to a considerable extent, a secondary one. The *real* instructors in a correspondence school are the men who have written the lesson papers which are placed in the hands of the students. Granting this, which, I venture to say, must be conceded, the success of any correspondence school, especially one teaching practical engineering subjects, must depend largely on the writers selected to prepare the lessons.

In this connection it may, therefore, not prove uninteresting to give a brief account of the method adopted by the writer in the organisation of the work of the Institute over which he presides.

Leaving aside the question of fundamental principles which, of course, every student must be taught, the writer, at the start, laid down the cardinal rule that when it came to the application of these principles to actual practice, none but *recognised experts* in their respective branches should be asked to prepare the lesson papers that were to go into the hands of the student.

These experts were, broadly, instructed somewhat as follows : "Given a student thoroughly prepared as regards mathematics, fundamental principles, &c., you are required to impart to this student the results of your *practical experience*. In the case of the design of a dynamo, for example, you are to show the student, step by step, exactly how *you* go about to design such a machine to have not only a certain efficiency, but to be so constructed that it can be sold at a profit. At every point you are to state clearly your reasons for the adoption of any one detail of construction in preference to another, where there is a choice. And, finally, you are to compare your own methods with those adopted by other recognised experts."

The experts selected were men who, in nearly every case, were connected with large manufacturing establishments, and whose names are household words in the electrical engineering community. While all of them undertook the tasks assigned to them, the writer knows that in every case it was done at considerable personal sacrifice, and in hours which ought to have been devoted to rest and recreation, and for which the writer will always be grateful.

The result is that this Institute may fairly claim that its students are instructed by the best practical experts in *all* the principal branches of applied electricity—a distinction which is believed to be unique, whether applied to a residential or correspondence school of engineering.

Just one word more. In the letters of your previous correspondents much stress is laid on the desirability of having an experienced man as a teacher of dynamo design. But why, it may be asked, should not *every* department of applied electricity in an electrical engineering school be similarly in the hands of an expert teacher ? What booteth it, for example, to have a generator of 96 per cent. efficiency at the station of a long-distance three-phase power transmission, if the transmission line is so badly designed that the loss turns out to be 20 per cent. where only 10 per cent. was allowed for, and in which the regulation is bad, to boot ?

Evidently what is wanted at our technical schools is not one, but a corps of practical experts, covering all the principal branches of applied electricity, and this ideal, the writer believes, has been realised in the school under his charge.

Joseph Wetzler,
President, the Electrical Engineer Institute of Correspondence Instruction.

London, *February 1st*, 1904.

The £ s. d. of Inventions.

Whatever new electrical plant one happens to see or hear of always embraces some improvements on the existing types in general use. Manufacturers never get tired of directing attention to them. They urge them as a guarantee that the plant will prove a good investment rather than the past records of the general utility of similar installations that have been at work for some time. Such improvements represent only a small proportion of the number of patents taken out by the manufacturers, which, in some cases, are so great that they must prove a tax on the resources of the former.

Then, patents in connection with plant that is extensively used, and in which some new idea is realised, ought to be of interest to such firms. They invariably are—but why does such interest embody nothing more nor less than curiosity ?

Stop Press.

[Our correspondent evidently speaks from bitter experience ; but the way of the inventor has ever been paved with disappointment. The vast majority of the inventions which are patented are utterly worthless. The firms in question are no more to blame than the book-lover, who turns over hundreds of musty old volumes in the hope of lighting upon one prize at last.—Eds. E.R.]

A "Canadian's" Complaint.

The very fact that "there are several firms of reputation in England who make a speciality of 'specials'" shows that the ordinary manufacturer hangs away from them.

I could cite many instances of this, but I appealed to the publicity of your valuable paper for one purpose only, *i.e.*, to get in touch with someone who would put himself about a bit. Your editorial note is, of course, quite correct, but one, at least, of the eminent firms that were open to disabuse my mind, had only some time before, when applied to, referred me to their Mr. So & So "who would show me what they had got."

Canadian.

The Falling of Trolley Wires.

With regard to the case in last week's issue of your journal *re* Watson *v.* the Mayor and Corporation of Sunderland, I was surprised on reading through the proceedings that the defendants were unable to suggest any explanation of the cause of the wire falling. As this matter will now raise an important question as to the liability of owners of electric tramways on the overhead trolley system, after the verdict returned by the jury at Sunderland last week, it behoves electric tramway owners to take steps to prevent a recurrence of the accident. The consequences attending an accident of this kind may be so appalling (especially in a busy thoroughfare) as to greatly hamper the progress of electric traction in the near future, to say nothing of the heavy damages that might be assessed against the owners.

It would be interesting to know the size of wire used at Sunderland, and whether the wire snapped close to an ear or other support, if so it may be similar to my experience with falling wires, in which case the following explanation in my opinion, may be the cause of the trouble.

I think the beginning of the trouble is due to the use of too light a trolley wire, combined with the sag that takes place a short time after the wires have been fixed, due to the subsidence of poles and changes in temperature. The wire being held fast in the ear is lifted by the pressure of the trolley and then falls after it has passed, thus having practically the same effect as one endeavouring to break a piece of wire by bending it backwards and forwards in the hands. This, I think, causes the wire to snap close to the ear nine cases out of ten, and even with close inspection, the

fracture in the copper cannot be detected until it has reached a certain point. If the weight of the wire together with a given tension resists the pressure of the trolley there will be no rising and falling of the wire, but this cannot exist for a long period, as the tension must fall, allowing the wire to sag. The weight of the wire in itself is not sufficient to resist the pressure of the trolley, and thus the wire is lifted, and falls by its own weight, causing a crack close to the ear, where it will finally snap. If a wire is used sufficiently heavy in itself to resist the pressure of the trolley without any great tension on the wire, we get the same result as with a light wire and a good tension, only with the former, any after sagging will not matter, whereas with the latter it is of vital importance. Of course, I am assuming, in making this suggestion, that the usual pressure of the trolley is fairly constant.

When the construction of a new system is under consideration it would be advisable, after determining the size of wire for its current-carrying capacity and voltage drop, to increase it in size, so as to make it heavy enough not to be affected by a trolley should any after sagging take place. This will do away with the pulling up of wires later on, which is a source of great touble and expense.

J. W. W.

Explosion of Enclosed Arc Lamps.

I regret that I was slightly wrong in my letter of last week, *re* the precise nature of the gases produced in the globe of an enclosed arc lamp; but the other points of my letter remain unaffected.

I have also noticed that an explosion will sometimes cause the top carbon to be shot upwards, clean out of the globe enclosure, to allow the gases to escape through the hole by which the carbon enters.

Herbert E. Angold.

London, S.W., *February 2nd*, 1904.

[Resin Solder.—A correspondent wishes to know the name of the makers of "resin solder"—*i.e.*, solder tubes with a core of resin.—Eds. E.R.]

REVIEWS.

Fire Insurance Rules.—Liverpool, London and Globe. 1903 Edition.

The rules of this company have always been, if not in advance, certainly not second to any in clearness, reasonableness, and common sense.

The present edition bears evidence of considerable revision, and we are pleased to note that, so far as regards ordinary risks, they are uniform in requirements with the latest rules of the I.E.E. In every case the number of the Institution rule, on which the company's rule is based, is given. In the introduction we read that new commercial applications of electricity necessitating special plant and accessories not covered by the rules will be dealt with "in a friendly and liberal spirit," and from personal contact with the Company's technical advisers, we are sure that this will be the case.

There are only one or two points calling for comment, and these but briefly.

Clause VI. of the introduction gives a list of the principal sources of fire loss, item three reading "Leakage of current from metallic armouring or from metal conduits to gas-pipes (the gas-pipes being thereby melted, and the issuing gas ignited)." Wood casing does not figure in the causes of fire, yet iron piping is clearly preferred. Rule 49 (based on the I.E.E. rule No. 29) stipulates that in tube work "means must be provided to prevent the accumulation of water in the tubing, arising either from condensation or other sources." This is more easily said than done, and we know of cases where tubing has had to be replaced by casing on account of the condensation of moisture in the tubes, and consequent leakage. Nothing short of an interior lining will in some cases prevent condensation; and with wires lying in the pipes, effective drainage is impossible.

The only other point we need comment upon is the note to Rule 16 (I.E.E. 70):—"It is recommended that all shunt circuits of motors be arranged so that the field is excited before the armature is connected, these circuits to be disconnected through a non-inductive resistance or carbon break after the armature circuit is broken."

As this is an Institution rule, we can hardly quarrel with the L. L. & G. Co. for adopting it, but we would point out that there is no need to break the shunt-circuit of a motor until it is demagnetised. The rule in question calls for linked switches (commonly called a D.P. switch), and a starting switch with "no-voltage" release. All that is necessary to stop the motor is to open the D.P. switch, and the starter will hold up until there is practically no current in the shunt winding, when the switch will come off. What is the use of providing a D.P. switch if the attendant is allowed to break the armature circuit with the starting switch?

The Royal Insurance Co.—This company's rules are practically identical with the above.

The Manufacture of Iron and Steel Tubes. By E. C. R. Marks. Manchester: The Technical Publishing Co. 1903.

Whereas the first gas-pipes used by Murdock were made of old gun barrels, of which, in the year 1815, no doubt vast numbers were to be bought, it has been unkindly said that to-day plenty of cheap gun barrels have been made of gas-pipe. This little book contains, to begin with, a history of early processes of pipe making, and it appears that almost or quite first in the field was one James Russell—presumably the founder of the present liberal and leading firm of Jas. Russell & Co., of Wednesbury.

After describing welded tubes, the author passes on to consider seamless tubes, the Mannesmann process of drawing, and others using conical or other peculiar rolls. There is nothing on pipe screwing, which is an omission that might be rectified with advantage in future editions. Far too little is known of pipe threads and joints and the proportions of gas, water, steam, artesian, flush-jointed and other varieties. Yet these are important details, and it is to be hoped that pipe joints have not been overlooked by the Engineering Standards Committee. There is a Whitworth standard for pipes; it is adhered to by Russell's and certain other makers, but some makers have their own dimensions which are not standard, and we have known great trouble and vexation arise from this. Indeed, we know of plenty of orders having gone to makers of standard sizes merely as a recognition of their adherence to the Whitworth sizes.

The Story of the Atlantic Cable. By C. Bright. London: George Newnes, Ltd. 1903. Price 1s.

This little book has been written apparently to provide a popular and brief account of the construction, laying, and untimely collapse of the first Atlantic cable. Beginning with an introductory sketch of the rise and development of telegraphy on land, and of the first submarine cables (between Dover and Calais), the author proceeds to describe the conditions obtaining when the Atlantic cable project was first mooted. Due credit is given to the various pioneers who took part in the preparations, and in the ultimate accomplishment of the undertaking—notably, Messrs. John W. Brett, Charles T. Bright, and Cyrus W. Field. The invaluable work of Prof. William Thomson (Lord Kelvin), Mr. Whitehouse, and others, is also recognised. The construction of the cable, and the first ill-fated attempt to lay it, are then described, after which the successful completion of the undertaking is chronicled, mainly in the words of the *Times* report.

The cable had but a brief active existence, but afforded abundance of experience, which enabled the promoters to proceed with confidence to repeated endeavours to bridge the Atlantic, which were crowned with success. The narrative is one of intense interest, and is moulded into an agreeable form. It is well worthy of perusal by those who wish to pass a few hours in reading of the heroic deeds of our forerunners.

PHYSICAL SOCIETY.

At the meeting held on January 22nd, 1904, Mr. W. Bennett read a paper entitled "Notes on Non-Homocentric Pencils, and the Shadows Produced by Them.—I. An Elementary Treatment of the Standard Astigmatic Pencil."

A paper by Prof. R. W. Wood on "Some New Cases of Interference and Diffraction" was read by the secretary.

A paper by Mr. S. Skinner "On the Photographic Action of Radium Rays" was taken as read. It is well known that a photographic plate by exposure to radium rays is affected in such a way that the plate develops similarly to its development after exposure to light. The experiments described in the paper are an attempt to answer the question: Are the actions the same? As far as can be seen, the final results of the actions and developments are the same, and the experiments appear to indicate that only slight differences occur in the early stages. The plates, suitably enclosed, were subjected to the rays from varying quantities of radium bromide for varying times, and the results showed that the intensity of the developed image increased rapidly to a maximum value with increase of exposure, then decreased first rapidly, and finally very slowly until a stage was reached in which there was practically no dark image formed on development. It is found that spark images are at first obliterated by radium rays which do not cause such a great density as that of the spark images obliterated, and that with prolonged exposure the radium rays reverse the spark images.

Mr. W. A. Price exhibited a number of instruments constructed by Messrs. Crompton & Co., Ltd. The instruments shown were chiefly switches, galvanometers, and potentiometers, and Mr. Price explained that the chief interest of the exhibit lay in the mechanical devices which had been introduced to overcome difficulties of design.

LEGAL.

Bright's Light and Power Co.

Mr. Justice Swinfen Eady on Friday heard a motion to appoint Mr. H. S. Foster receiver and manager of the above company. The company offered no opposition, but the River Plate Electricity Co., who had a prior mortgage, had been joined as defendants. It was a debenture holder's action brought apparently for the purpose of enforcing a subsequent security, and plaintiff did not offer to redeem the River Plate Co. Mr. Eve, K.C., M.P., therefore, on their behalf opposed the motion.

His Lordship refused to sanction the appointment.

Grant v. Venner James & Co.

Mr. Justice Swinfen Eady in the Chancery Division on Friday heard a motion to appoint a receiver and manager in this debenture holder's action. The defendant company were manufacturers of electrical accumulators. A winding-up resolution had been passed, but a manager was required to complete orders in hand.

His Lordship appointed a receiver and manager for a month.

Smith v. National Electric Wiring Co.

At Northampton County Court last week, H. W. Smith, electrical engineer, sued the defendants for £3 14s. 5d., for goods supplied, and for testing electrical work at Northampton Arcade. There was a counterclaim for the return of certain documents, and £4 for their detention. The papers were described as "a copy specification of a contract between the defendants and the Northampton Estates Corporation, a report of Messrs. Lea & Warren, electrical engineers, and other papers and documents." Letters were put in in which plaintiff called attention to defects in the installation, and the Judge remarked that he did not know what a report was unless they were. A witness for the defence admitted that amongst the documents for which the company counterclaimed were reports of electrical experts condemning the installation at the Arcade, where the inspection was made, as unsafe.

Judgment was given for the plaintiff for the amount claimed, and Mr. Smith was ordered to return the papers referred to in the counterclaim.

Phillips v. The London General Omnibus Company and the London United Tramways (1901), Ltd.

In the Court of Appeal, on Monday, a stay of execution was granted, pending the appeal of the companies from verdict and judgment entered in the King's Bench Division, before Mr. Justice Grantham and a special jury, when Mr. and Mrs. Phillips obtained a verdict for the plaintiffs against both companies for £2,500 damages and £422 in respect of special damage.

It was arranged that there should be a stay on the companies paying down to the plaintiffs the £422 in respect of the special damage, to be retained by them in any event, and paying the £2,500 damages into a bank on deposit account within fourteen days.

BUSINESS NOTES.

Electrical Wares Exported.

Week ending Feb. 3rd, 1903.		Week ending Feb. 2nd, 1904.	
Alexandria	Value £25	Alexandria	Value £315
Amsterdam	87	Amsterdam	82
Bilboa	26	Antwerp. Elec. fuse	198
Bombay	134	Auckland	258
Brisbane	67	Azores. Teleg. instruments	2,800
Buenos Ayres	153	Bombay	219
" Teleg. mat.	761	Buenos Ayres	95
Calcutta	2,360	Calcutta	644
" Teleg. cable	194	" Elec. machinery	1,700
Cape Town	785	Cape Town	44
Colombo Teleg. mat.	88	" Teleg. mat.	14
Durban	2,660	Colombo	119
" Teleg. mat.	1,353	Channel Islands	326
East London	375	Delagoa Bay	650
Fiji. Teleg. mat.	334	Durban	773
Flushing	300	East London	30
Gibraltar. Teleg. wire	224	Gibraltar	340
" Teleph. cable	113	" Teleg. mat.	225
Melbourne	280	Halifax	40
North Atlantic. Teleg. cable	1,260	Hong Kong	18
Perth	136	" Teleph. mat.	156
Port Elizabeth	168	Launceston	1,537
Reval. Teleg. cable	300	Lyttelton	12
Rotterdam	7	Madras	71
Singapore	62	Melbourne. Teleg. cable	220
Sydney	70	Nagasaki	54
Syra. Teleg. mat.	53	Oporto. Teleph. mat.	49
Wellington	190	Perth	81
Yokohama	214	Rangoon	12
" Teleg. cable	694	Rotterdam	13
		" Teleg. wire	20
		Singapore	23
		" Teleg. cable	140,000
		Sydney	789
		Tokosuka. Elec. light cables	583
		Wellington	46
		Yokohama	130
Total	£13,473	Total	£152,656

Foreign Goods Transhipped.

Boston. Elec. mat.	Value £52	Buenos Ayres. Elec. mat.	Value £230
Boulogne. Elec. goods	52	Melbourne. Elec. apparatus	46
Calcutta. Elec. mat.	93		
Total	£197	Total	£276

New Portable Testing Set.—Messrs. Nalder Bros. and Thompson, Ltd., have recently placed upon the market a new portable testing set, which contains many points of novelty. This set has been specially designed to meet the demand for an instrument that can be used in an engine room, and can be placed anywhere without the danger of obtaining erroneous results through stray fields. The screening of the instrument has received very careful attention, and is so efficacious that it is almost impossible for the reading to be affected, even if it be placed quite close to a dynamo or motor. The instrument is of the moving-coil type, being

Combined Ammeter and Voltmeter.

absolutely dead-beat; it is fitted with a white enamelled metal scale and a metal mirror. The voltmeter resistances are carried in the instrument itself, and the current shunts in another case. Measurements up to 1,500 amperes and 600 volts can be made, and, as a double-pole change-over switch is provided, resistances can be measured by the practically simultaneous observation of current and potential difference. The pressure required to deflect the pointer to the top of the scale on the ammeter side (terminals A A) is ·12 volt, and, as the scale is divided into 120 divisions, each division corresponds to ·001 volt, so that the fall of volts on rail joints, &c., can be conveniently tested. The current shunts are of a new design, and very convenient for connecting, in addition to which they are light, and a complete set to 600 amperes can be carried in quite a small box.

The "Union" Excello Intense-Flame Arc Lamp.—Lamps of the above pattern were selected to replace the enclosed arc lamps, which have been in use up to the present, on the occasion of the Union Jack Club Ice Carnival, held during this week. It is claimed that the "Excello" lamp has an economy in current consumption of over 71 per cent, and an increase in effective illumination of over 60 per cent. as compared with the enclosed type of arc. The makers are the Union Electric Co., Ltd., of 151, Queen Victoria Street, E.C.

Engine Contracts.—A large number of engine contracts have lately been booked by Messrs. W. H. Allen, Son & Co., Ltd., of Bedford. For the Admiralty they are to supply an engine coupled to a dynamo for H.M.S. *Canopus*, and five engines coupled to dynamos for H.M. ships *Albion*, *Glory*, *Ocean*, *Vengeance* and *Goliath*, also two engines coupled to dynamos for H.M.S. *Thames*. The London Electric Supply Corporation, Ltd., have placed a contract for two engines for direct-coupling to centrifugal pumps at Deptford. Messrs. W. O. Rooper & Co. have ordered two engines for coupling to the Electric Construction Co.'s dynamo for the Portland Hospital. Two engines for direct-coupling to centrifugal pumps at the Yoker power station have been ordered by the British Westinghouse Co. Messrs. A. H. Briggs & Co., of Bradford, have ordered an engine for direct coupling to a British Westinghouse dynamo. From Messrs. Laird Bros., Messrs. Allen have received a contract for 21 engines for H.M. ships *Liffey*, *Moy* and *Ouse*, and various other engine orders for brewery installations and shipwork.

Some Maxim Contracts.—The tender of the Sir Hiram Maxim Electrical and Engineering Co., Ltd., for steam and other piping for the Dewsbury electricity works has been accepted by the Corporation; the Underground Electric Co., Ltd., has accepted their tender for 100 miles of stamped steel troughing for the electrification of the Underground Railway. The Maxim Co. has also received a contract from Messrs. W. O. Rooper & Co., Ltd., for pipework in connection with the electrical installation for the Royal Naval Hospital, Portland. The National Provincial Electric Corporation, Ltd, has accepted the company's tender for the complete equipment, including the whole of the machinery in the generating station and the cables, for the electric lighting of Bridgwater, at £13,000. Messrs. Arthur Koppel have placed with the Hiram Maxim Co. the contract for the pipework in connection with the cooling towers for the Oldham electricity station, and at Bath the same company has recently carried out the pipework for the new tramway station, as sub-contractors to the British Westinghouse Co.

Automatic Fire Alarms.—The May-Oatway Fire Appliances, Ltd., of Glasgow, have let contracts for installations recently advertised on their system as follows:—The premises of Messrs. Brown & Polson, Paisley, are to be fitted by Messrs. Allan Arthur & Ure; and those of Messrs. John Ireland & Sons, of Dundee, by Messrs. James Maxwell & Son. The Midland Railway has just placed with the May-Oatway Co. orders for their automatically-controlled automatic detectors and indicators for the protection of the new station buildings, goods sheds, &c., at Heysham. The Liverpool Overhead Railway, which adopted the May-Oatway system after the fatal fire at the Dingle Station, was closely followed by the Lancashire and Yorkshire Railway, which has applied it to various buildings.

Calcium Carbide.—Large new works for the manufacture of calcium carbide are about to be established at Chorro, on the Cordova—Malaga Railway, Spain. The works will be operated electrically by a plant which is being put down by the Sociedad Hidroelectrica del Chorro, to utilise certain available water-power in the neighbourhood.

Water Distillers and Condensers.—In our article on "Water Distillers and Condensers" last week, a clerical error occurred. The statement that the condensers turned out by the Mirrlees Watson Co. during last year were capable of dealing with nearly half-a-million lbs. of steam, should have read "1½ million lbs. of steam." We further understand that owing to some fairly large orders coming in during the last few days of the year, the actual amount of steam was considerably in excess of 1½ million lbs.

Vienna Cable Works Suspend Payment.—A Continental correspondent reports that the cable works of Otto Steiner, in Schwechat, near Vienna, have suspended payment. The debts amount to 600,000 crowns, and foreign countries are interested.

Catalogues and Calendars.—Messrs. Jackson Bros., electrical engineers, of Plaistow, have issued a calendar for the current year, with monthly sheets, but each having a small complete calendar for the year. Each sheet has also a photographic view of lighting, telephone and fire alarm installations or plant supplied by the firm.

From the Niles-Bement-Pond Machine Tool Co., of New York (and Victoria Street, S.W.), we have received a wall calendar with a print of a charming painting by H. Rondel, the subject being "A Reverie."

Messrs. Thomas Thompson & Co, of 35, New Broad Street, E.C., have sent us a pamphlet containing a description of their Aumund's patent tachometer, which, we understand, is in use in many of the more important electric generating stations throughout the country, and is being adopted by some of the leading engine builders. The Aumund tachometers are claimed to be most sensitive and efficient.

The Lahmeyer Electrical Co., Ltd., has sent us a copy of its pamphlet, No. 8, describing the advantages of separate electrical driving of tools, lathes, and other metal working machines. A number of interesting illustrations are given.

The picture postcard has been adopted by the General Electric Co., Ltd., as an attractive way of bringing their "Little Geeko" 'phones before the attention of the householder. The simplicity of the arrangement is illustrated in its use by the piccanninny and puppy section of the domestic circle.

Messrs. W. F. Jones & Co., of 50, Cannon Street, E.C., are making a speciality of main switches, switchgear, switchboards and rheostats, and they have just issued a 16 pp. price list, giving illustrations and dimensional diagrams of their various types of switches. Descriptive notes appear explaining the quick-break "I." and "II." type switches, for 250 and 500 volts, with and without fuses. A special feature is made of the manufacture of silver wire and silver sheet fuses, also enclosed fuses.

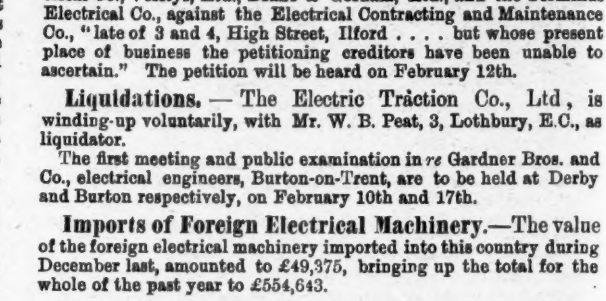
Bankruptcy Proceedings.—The *London Gazette* contains notice of a bankruptcy petition presented by the Sloan Electrical Co., Veritys, Ltd., Drake & Gorham, Ltd., and the Terminus Electrical Co., against the Electrical Contracting and Maintenance Co., "late of 3 and 4, High Street, Ilford . . . . but whose present place of business the petitioning creditors have been unable to ascertain." The petition will be heard on February 12th.

Liquidations. — The Electric Traction Co., Ltd, is winding-up voluntarily, with Mr. W. B. Peat, 3, Lothbury, E.C., as liquidator.

The first meeting and public examination in *re* Gardner Bros. and Co., electrical engineers, Burton-on-Trent, are to be held at Derby and Burton respectively, on February 10th and 17th.

Imports of Foreign Electrical Machinery.—The value of the foreign electrical machinery imported into this country during December last, amounted to £49,375, bringing up the total for the whole of the past year to £554,643.

New Change-Speed Gear for Motor-Cars.—Messrs. the Langdon-Davies Motor Co., Ltd., are introducing a new type of change-speed gear for use in motor-car work. As will be seen from the diagram, the gear-wheels are always in mesh, and are locked to the shaft as required by interlocking jaw-clutches. When the clutch pedal is pressed down, it first releases the sliding clutch, then unclutches the wheel which happens to be in gear, and allows the selection of another gear-wheel. When the pedal is released and rises, the spring pulls the cam-shaft *o*, and, through the medium



New Change-Speed Gear.

of one of the forks *u*, *v*, *w*, operates one of the clutches *l*, *m*, *n*. The clutch *l* engages the shaft *k*, giving a direct drive at top speed. The pins and slots *z* on the rod *p* prevent the handle *x* from being moved, except when the pedal is fully depressed, and also prevent any but the selected gear from being engaged, the handle being definitely locked except when the pedal is depressed. The system is, of course, applicable to more than the three speeds and reverse as shown in the diagram, and will be on view, both fitted to a van and separately, at Messrs. Langdon-Davies' stand (No. 235) at the forthcoming Crystal Palace Motor-car Show.

Parliamentary.—Standing Orders.—Amongst other Bills which have now been before the Examiners, and have been found to comply with the Standing Orders, is the Cheshire Electricity and Power Gas Bill.

Coulsdon Tramways.—It is understood that the Coulsdon Tramways Bill will not be proceeded with.

Basingstoke Corporation.—There was no appearance on the part of the promoters before the Examiners in the case of this Bill, and it was accordingly marked "Dead." Amongst other powers which it was the intention of the Corporation to seek was power to supply electric fittings, and to appropriate certain lands for a generating station and dust destructor.

Classification of Private Bills.—It has been decided that the following Bills shall originate in the House of Lords:—Belfast and North-East Ireland Electricity and Power Gas, Belfast Corporation Tramways, Bexhill Corporation, Bournemouth Corporation Tramways, Bristol Tramway Extensions, Chesterfield Corporation Tramways, Derbyshire and Nottinghamshire Electric Power, Great Yarmouth Corporation, Holywood Tramways, Ilford U.D.C., Isle of Thanet Light Railways, Lancashire Electric Power, Leicestershire and Warwickshire Electric Power, Manchester Corporation Tramways, Metropolitan Railway, Metropolitan District Railway, Mid-Cheshire Tramways, Newcastle-on-Tyne Corporation, North Wales Electric Power, Portmadoc, Beddgelwt and South Snowdon Railway, Preston and Blackburn Tramways, Preston and Lytham Tramways and Tramroad, Southport and Lytham Tramroad, Preston, Chorley and Horwich Tramways, Stretford U.D.C., Tyneside Tramways and Tramroads, Ulster Electric Power, and West Riding Tramways.

Trade Announcements. — The Siemens Electric Appliances Co. has taken corner premises at 32, Watling Street, nearly opposite their headquarters, and facing the well-known fire station. The position is an appropriate one, seeing that the chief purpose in view is to make it a depôt for the exhibition and sale of

the fire-station appliances manufactured by the company. We understand that their Lilliput arc lamp introduced not long since, has been found to meet requirements that had not been satisfactorily met by some other lamps. New uses are being continually found for it, and it has been improved in several ways since it was first put on the market.

Owing to the continued increase of business in the Midlands, the Hart Accumulator Co., Ltd., has opened a branch office at Prince's Chambers, Corporation Street, Birmingham, and has appointed Mr. F. R. Hill to the position of local manager.

Owing to the increased business, Messrs. Peto & Radford, Ltd., have amalgamated with the "P and R" Storage Battery Co., Ltd. As intimated in these columns last week, these companies are being wound up, and a new company under the title of Peto & Radford, Ltd., has been registered to take over the two companies as a going concern, as to discharge their liabilities, &c.

The Electric and Ordnance Accessories Co., Ltd., have recently appointed Mr. V. J. Delebecque to be their chief representative in the British Isles.

Messrs. Royce, Ltd., of Manchester ("Royce" dynamos, electric motors, cranes, switches, &c.) have appointed Mr. E. C. Amos, M.I.Mech.E., 20, Bucklersbury, E.C., sole representative for the London district.

The South Lancashire Electric Traction and Power Co., Ltd., South Lancashire Tramways Co., and the Lancashire Light Railways Co., Ltd., removed their head offices to 9, North John Street, Liverpool, on February 1st.

In order to meet the growing demands of business in the Glasgow district, and for the convenience of clients in Scotland, the "Paul" Heater and Condenser Co. have appointed Messrs. Herbert and Gilchrist, Wellington Chambers, 146, West Regent Street, Glasgow, as their agents. The London office (63, Queen Victoria Street, E.C.) is now under the management of one of the directors, Mr. R. H. Haylock, who was for many years chief engineer to the Sturtevant Engineering Co. A preliminary list of the specialities which they are manufacturing at the present time includes all descriptions of engine and boiler room steam appliances, also electric fans, &c.

Book Notices.—*Science Abstracts.*—With the January numbers of *Science Abstracts*, a new era commences in the history of this publication, the work of compiling and editing the abstracts having been taken over entirely by the staff of the Institution of Electrical Engineers, under its late chief, Mr. W. G. McMillan, whose lamented death has plunged us all into mourning. Strenuous efforts are being made to bring the abstracts up to date, a Herculean task owing to the six months' arrears into which they had fallen. In future, abstracts will appear as soon as possible after the original articles, and the arrears will be worked off by degrees, so that in the meantime abstracts of articles which were published respectively in May and November last year appear together. The two sections—Physics and Electrical Engineering—are now provided with buff and red covers respectively, so as to readily distinguish them. The staff of abstractors now numbers 85, and articles are *résumé* from 150 journals.

Elektrisch Betriebene Strassenbahnen. By S. Herzog. München: R. Oldenbourg. 1903. Price 8m. This pocket-book forms a remarkably complete epitome of electric tramway practice in Germany; it is well printed, in clear type and on good paper, and has a neat leather binding with a spring clasp, making it really suitable for the pocket. The illustrations of details of track construction, cars and their equipment, overhead and underground construction, and diagrams of electrical connections, are both excellent and numerous. Following the descriptive part is a short section on drawing up specifications and estimates for the construction of an electric tramway. Other sections deal with the efficient working and management of the system, and there are numerous tables of technical data relating to electrical, mechanical and physical matters, mathematical tables, Government regulations, &c. The index is quite inadequate, and ought to be greatly extended; but, apart from this fault, the book is worthy of our highest praise and should prove invaluable to those who have command of the German language.

Kalender für Elektrochemiker, 1904. By Dr. A. Neuburger Berlin: M. Krayn. Price 4 m.—This is the eighth edition of the useful pocket-book compiled by Dr. Neuburger, who is the editor of the *Elektrochemischen Zeitschrift;* it contains a vast amount of technical data relating to electro-chemistry, in a convenient form, including information on electrical units and measurements, the electrical constants of metals, chemical compounds, &c., primary and secondary cells, and a large number of electro-chemical and metallurgical processes. The book is accompanied by a supplement, giving a great number of mathematical, physical, mechanical and other constants and data, and Governmental regulations. This work should be most useful to electro-chemists, being, so far as we are aware, practically the only one of the kind on the market. Unfortunately, although there is a table of contents, there is no index; this is a serious drawback, which we hope will be remedied in later editions.

"Il Nuovo Cimento: September, 1903." Organo della Società Italiana di Fisica. Piza: Istituto fisico della R. Universita.

"Decennial Catalogue of the Massachusetts Institute of Technology. Class of 1893, 1903." Boston, Mass: The Institute.

"Science Abstracts." A. Physics; B. Electrical Engineering; Indexes to each section of Vol. VI. London: E. and F. N. Spon, Ltd. 1s. 6d. each.

"L'Année Electrique Revue de 1903," by Dr. Forean de Cournielles. Paris: Ch. Béranger. 3.50 fr.

For Sale.—Messrs. P. Huddleston & Co. are on February 11th offering certain engineering plant for sale at Baltic Street, Golden Lane, E.C. See our advertisement pages to-day.

Ediswan Motor Van. — Owing to the increasing demand for the "Royal Ediswan" electric lamp, and the difficulties experienced in getting stocks delivered quickly enough, the Edison & Swan United Electric Light Co. decided to adopt motor traction for this purpose, and the first of their motor vans recently commenced its duties. This van makes a daily trip from the works at Ponder's End with a stock of lamps for the head office in Queen Street, City; thence supplies are taken to the various contractors in other parts of London. On its return in the evening, the van carries a load of empties and raw material. The vehicle is rated as a 9½-H.P. 2-ton lorry, and is 16 ft. 11 in. long × 6 ft. 5 in. wide overall.

Joint-Box Compound.—We have received from Messrs. Bradshaw & Co., of 52, Queen Victoria Street, E.C., a sample of their joint-box compound for insulating purposes. This compound is guaranteed to withstand the highest insulation tests, and is supplied in 14 lb. tins with loose lids. The firm are also large manufacturers of troughing bitumen.

LIGHTING AND POWER NOTES.

Barking.—The T.C. has instructed the electrical engineer to prepare a scheme for supplying power to Crocksmouth.

Beddgelwt.—The P.C. has unanimously decided to support the North Wales Electric Power Bill.

Bedford.—The engineer has been instructed by the T.C. to prepare a scheme and estimates for additions and improvements at the electricity works, and for mains extensions.

Birtley.—The Co-operative Society has asked the consent of the Chester-le-Street R.D.C. to its applying to the B. of T. for a prov. order to light the district by electricity.

Caerphilly.—No less than 10 objections have been received by the U.D.C. to its application for a prov. order for E.L. Three are from railway companies; the others emanate from Cardiff T.C., the Rhymney and Aber Gas and Water Co., two colliery companies, Lord Windsor, and another private individual.

Chorley.—The B. of T. has consented to extend the time for carrying out the E.L. order for a year.

Dalkey.—A company has informed the U.D.C. that it proposes to light Pembroke and Bray with electricity; and supply private consumers at 4½d. per unit.

Dundee.—A scheme is stated to be on foot whereby a a quarter of a million is to be expended on a power scheme to supply energy in bulk to mills and factories in the district. Messrs. Handcock & Dykes are stated to be connected with the scheme.

East Cowes.—The U.D.C. has sealed an agreement with the I.O.W. Electric Lighting Co. for public lighting.

East London and Lower Thames Electric Power Bill.—The Poplar and Shoreditch B.C's. have decided to oppose this Bill.

The Bermondsey and Deptford B.C.'s have also resolved to oppose this project. The Deptford B.C., it is stated, are pledged to support the L.C.C., should it again decide to promote a Bill for lighting the district.

Enniscorthy.—The L.G.B. has sanctioned the expenditure of £6,500, applied for by the Wexford C.C. for the purpose of carrying out an electric lighting scheme.

Germany.—Tenders are about to be invited by the municipal authorities of Vohrenbach (Baden), for the establishment of an electric lighting undertaking in the town.

Grimsby.—The Corporation has resolved to oppose the Lincolnshire and Yorkshire Electric Power Bill on the ground that if the company succeeds in obtaining powers to supply energy in its district, it will be detrimental to the borough undertaking.

Halifax.—The T.C. has appointed a deputation to discuss with the Mytholmroyd U.D.C. the question of supplying the latter district with electricity in bulk or otherwise.

Hartlepool.—The formal inauguration of the electric light undertaking took place on the 24th ult., the ceremony being performed by the Mayor. The Corporation obtained a prov. order in 1899, and signed an agreement with the Northern Counties Electricty Supply Co. last year, for the working of the order. Energy is supplied on three-wire system, D.C. at 230 volts for lighting, and 460 volts for power. The prices fixed are—for lighting 4½d. per unit, and for power 2½d. per unit.

Hull.—The T.C. has applied for a loan of £10,000 for the provision of additional E.L. plant and mains.

Hungary.—An electric power plant is about to be put down in connection with the Archduke Friedrich's collieries at Zakarfalva and Bindte.

Italy.—A concession has been granted to La Società Elettrica di Bormis, to put down a plant to utilise the water power of the River Adda for generating electrical energy.

Lincolnshire.—The C.C. has decided to oppose the Bill of the company, which proposes to supply the whole of the county with electricity for lighting and power purposes.

Littlehampton.—Three companies are at present negotiating with the U.D.C., with the object of securing a prov. order for the lighting of the district. A private concern proposes, should the Council give its consent, to supply energy to Littlehampton, Wick and Arundel. The National Electric Construction Co. is prepared with a similar scheme, excluding the latter area, and the National Provincial Electricity Corporation has also intimated that it would be prepared to light the Council's area.

Liverpool.—The expenditure for the year in the Liverpool electrical supply department is estimated as follows:—On capital account, £277,765; on revenue account, £161,345; and on interest and sinking fund account, £252,715.

London.—Fulham.—The B.C. has resolved that 25 incandescent electric lamps and 25 Nernst lamps shall be experimentally tried, at a cost of £200, in place of existing street gas lamps.

Marylebone.—The report of the representatives of the B.C. appointed to continue negotiations with the Metropolitan Electric Supply Co. was presented at a special meeting of the Council, on 1st inst. The report stated that the company had now expressed willingness to take bonds bearing interest at 3¾ per cent. in payment of the award of £1,212,000, and on the new capital expenditure to the end of 1904, which was estimated at £150,000. The company was prepared to pay, as rent, interest at 3¾ per cent. on these bonds, to pay the whole expense of their issue, and to contribute, as additional rent, £7,000 per annum, which would go as a contribution towards the Council's sinking fund. In addition to this the company, from January, 1913, would give the Council 10 per cent. of its total net profits, after deducting 4½ per cent. on the total capital employed, with 1½ per cent. for depreciation. The Electric Committee recommended that if the poll of electors with reference to the E.L. Bill resulted in favour of its promotion, the Council should, before attempting to work the undertaking itself, endeavour either to make some satisfactory arrangement with the company, or to enter into an agreement with a company of sufficient financial ability temporarily or permanently to work the undertaking on behalf of the Council. For the purpose of enabling the Council to continue negotiations, the Council recommends that the Bill be proceeded with.

Neath.—The R.D.C. has decided to apply to the L.G.B. for leave to borrow £20,000 for the purposes of electric lighting. The E.L. order has been extended for six months.

Newport.—A L.G.B. inquiry was held on 29th ult. into the application of the T.C. to borrow the sum of £60,500 for electrical purposes.

Nottingham.—The plant at the Eastcroft destructor and electricity works consists of 12 cells, between each of which there is a Babcock & Wilcox water-tube boiler. The arrangement of charging is on the Boulnois-Brodie system. Good results have been obtained with this plant; 4,878 units being generated from 75 tons 6 cwt. on January 12th, equivalent to 64·75 units per ton. The generating plant consists of two 240-H.P. Willans-Siemens sets. Another set is shortly to be installed as a stand-by.

Portishead.—The U.D.C. decided to consent to the application of the Western Electric Distributing Corporation for a prov. order for E.L. in the Council's area, and at the same time an agreement with the syndicate was sealed.

The Shawinigan Water-Power Scheme.—This scheme, the second largest in the world, has been developed by the Shawinigan Water and Power Co. for generating electricity for industrial and lighting purposes throughout a very considerable area around the St. Maurice River, Quebec. According to the *Boston News Bureau*, Canadian and American capitalists combined to undertake the installation of a plant at the Shawinigan Falls, on the above river, and upwards of $3,000,000 have already been expended. A feature of this development is, that the company is in a position to transmit to the city of Montreal a practically unlimited amount of energy. There is now being transmitted to the Montreal Light, Heat and Power Co. over 6,000 H.P., the distance being about 90 miles. In utilising the power at the Falls, no damming was required, there being, with little or no preparation, a natural head of 150 ft. On the Shawinigan—Montreal transmission line energy is transmitted at a pressure of 55,000 volts. Westinghouse transformers are used for reducing the pressure at Montreal The power available at the Falls at high water is stated to be equal to 500,000 H.P., and at low water a minimum of 150,000 H.P. The company has developed about 100,000 H.P., and of this amount has contracted to supply 35,000 H.P., 13,000 H.P. in water-power at the Falls, and 15,000 H.P. in electrical energy to Montreal. It was estimated that, by January, 1904, the company would be in receipt of an income at the rate of $225,000 per annum.

At the Shawinigan Falls other interests, including the Pittsburg Reduction Co., of Pittsburg; the Belgo-Canadian Paper Co., of Brussels; the Shawinigan Carbide Co.; and the Electro-Manganese Co. have plants representing a total expenditure of another $3,000,000.

Spain.—An electricity works has just been completed at Navas (Caceres), for the electric lighting of the small towns of Navas, Brozas and Garrovillas. The plant at present consists of two 84-H.P. gas generating sets.

Sudbury.—The Corporation has sealed an agreement with the Empire Electric Light and Power Co. for the electric lighting of the town. The company undertakes to install ½-ampere Nernst lamps for one-third of the public lighting and 16-C.P. incandescent for the remainder, at £2 each per annum. Prices to consumers are not to exceed 7d. per unit for lighting and 4d. per unit for power. The Corporation is to sell to the company all waste steam from its refuse destructor at 3d. per kilowatt-hour, and to have the option of purchase after 21 years, and at the expiration of every subsequent five years. No sum is to be paid for compulsory purchase.

Sunbury.—The T.C. has resolved to support the application of the Twickenham and Teddington Electric Supply Co. for a prov. order to light the district subject to the agreement entered into by the T.C.

Sunderland.—The Corporation Electricity and Lighting Committee has just issued its half-yearly estimate for the period ending September 30th; this contemplates an expenditure of £10,751, the chief items of which are as follows:—Rents, rates and taxes, £1,561, and insurance, £200; salaries, £1,433; wages, £1,785; coal, £3,446; repairs, £1,050, and other smaller items, making the expenditure named. The revenue is put down at £15,379, made up as follows:—Lighting and motors, 865,000, B.T.U., £7,972; traction, 762,000, B.T.U., £5,953; public street lamps, £1,142, and other small items. There is thus a gross profit of £4,628, but the bulk of this is swallowed by the interest on £250,000, less tax, £4,175, leaving an estimated profit of £453. These figures compare with an actual expenditure for the corresponding half of last year, £8,613, a gross revenue of £12,988, and a net profit of £841.

Sweden.—A contract has been placed for the establishment of a municipal electricity works in the town of Hudikwall.

Tottenham.—At the D.C. meeting on 2nd inst. the Electricity Committee recommended the Council to lay down a generating station in connection with its refuse destructor. Messrs. Hawtayne and Zeden's report on the cost of the proposed work stated that the destructor plant would probably supply about 350 I.H.P. The Council were also asked to consider the desirability of also putting down additional boiler plant in connection with the refuse destructor to increase the capacity of the works to 300 KW. The cost of the 200-KW. scheme was estimated at £18,000, with £7,450 for providing the necessary transformers and mains, including road work, &c., and of an alternative 300 KW. installation at £30,000.

Tunstall.—At the meeting of the U.D.C. on the 1st inst., it was reported that Burslem T.C. had offered to supply energy in bulk, provided that not less than 50,000 units per annum for seven years were taken, at the following rates: 2d. per unit up to 100,000 units, 1½d. for all over 100,000 to 200,000, and 1d. beyond. The Council decided to accept these terms, provided there are no legal disabilities.

Walton.—The U.D.C. has given the Urban Electric Supply Co. permission to lay mains in the district, and has decided to entertain the company's proposal to light a portion of the town by electricity. Experiments with various lamps are to be made, it is stated, on the advice of Col. Crompton.

Wednesbury.—Mr. Warden-Stevens has been appointed engineer of the Corporation electrical undertaking for the ensuing 18 months, at a salary at the rate of 75 guineas per annum.

Wheatley.—The U.D.C. has decided to oppose the Bill to confer powers on the Doncaster Corporation to extend its electricity undertaking into neighbouring districts.

Willesden.—At the last meeting of the U.D.C. the Council's electrical engineer was asked for an explanation of his dealings with the North Metropolitan Power Co. in regard to the proposed electrical undertaking of the Tottenham U.D.C. He admitted an unremunerated friendly arrangement, and it was decided that he should furnish a written explanation for the consideration of the Council.

TRAMWAY AND RAILWAY NOTES.

Aberavon.—A syndicate is being formed to apply to Parliament for powers to establish an electric tramway scheme between Taibach and Aberavon.

Belgium.—According to an agreement with the Liége-Seraing Tramway Co., the Société Parisienne pour l'Industrie des Chemins de fer et Tramways will carry out the work of transforming the system of working this line into an electrical one.

Birmingham and Aston.—In regard to the note in our issue of 22nd ult., where mention is made that the fares between Birmingham and Aston have increased through the service being divided, Mr. H. T. Broughall, of Birmingham, writes:—"You state that the fare, which was originally 2d., is now 3d. May I be allowed to point out that this is a mistake? Take, for instance, the Gravelly Hill route. The B.E.T. Co.'s steam cars meet the Birmingham Corporation cars within about 50 yds., and take the passengers all the way for 1d., thereby making the total fare from Birmingham 2d., as hitherto. In the matter of return fares, what was hitherto 4d. will now be

3½d., the Corporation of Birmingham granting return tickets from Birmingham to its boundary for 1½d., the B.E.T. Co.'s fares being 2d. return from there to Gravelly Hill. Therefore, the B.E.T. Co. are giving the benefit of Aston's delay to the public."

Blackburn.—An official statement of the working of the Corporation trams during the nine months ending December 31st last states that there was a loss amounting to £2,144. The receipts increased from £32,832 to £34,177. This brings the total loss on the tram undertaking to £24,640.

East Cheshire.—Disappointment is felt at Stalybridge and Hyde at the opposition which is threatened to the electric tramway scheme for connecting those towns with Glossop and the Langdendale Valley *vid* Mottram and Hollingworth. The chief opponents are the Mottram Urban Council, in whose district about one-half of the total length of 7¼ miles of proposed line is situated. Their ground of objection is that, under the order, which is sought by a private syndicate, it is not proposed to effect a junction with any existing or authorised lines, and that the scheme as it stands would have, in consequence, to be worked as a separate and independent undertaking, without the possibility of a through service. The objectors say that the scheme presented is not likely to succeed, and they urge the Light Railway Commissioners—to whom application is to be made—not to sanction it unless they are satisfied that the promoters are able and prepared to carry out a through scheme in connection with other existing lines. They would welcome the construction of tramways to connect Hollingworth and Mottram with Stalybridge, Hyde and Glossop, but doubt whether any connecting link can be established successfully except as part of the system (now in course of construction) of the Stalybridge, Mossley, Dukinfield and Hyde Tramways and Electricity Board, or of the system now in operation within the borough of Glossop. The thing desired is through communication for the inhabitants of Mottram with Glossop, Stalybridge and Hyde, without change of car, and for a through fare. The objectors also ask for a shorter time limit for the construction of the line—namely, two years instead of the five years desired by the promoters.

East London Railway and Electric Traction.—Speaking at the half-yearly meeting of the East London Railway Co., on the 26th ult., on the question of electrification, Mr. A. E. Gathorne Hardy, the chairman, said that the deadlock between the Metropolitan and the District and the other leasing companies still continued. The facts were as follows:—In 1902 the Metropolitan and District Cos., who were taking steps to work their systems by electricity, proposed in their Bill to take power to electrify the East London Railway. They asked the Joint Committee to find the money to equip this line for electrical working on the undertaking that nothing in the installation should prevent the use of the line by steam power. The other companies pointed out that the installation of electrical working was required only by the Metropolitan and District Cos., and that, therefore, they did not see their way to participate in the cost of the installation, although they had no objection to the two interested companies carrying out the work at their own cost, provided that it did not interfere with the user of the line by steam power, and subject to the satisfaction of the Joint Committee's engineer; furthermore, on the understanding that if, in future any other company made use of the installation, they could do so on sharing the expense thereof. On March 10th, 1902, the managers of the Metropolitan and District Railways wrote to the Joint Committee pointing out that they should work by electricity on the Inner Circle and City lines, and that, "if an efficient service by our trains is to be continued on the East London Railway, it must be by the same motive power"; and they made further proposals that the Joint Committee should find the capital or pay interest thereon at 3½ per cent., "with a view of preventing the disorganisation of the service or, probably, the discontinuance of it." The other companies adhering to their decision, the clauses in the Bill were withdrawn. He found that the chairman of the District Co., at his meeting on the 19th ult., described the terms of the other companies as "onerous and absurd." Mr. Perks said that the directors of the East London Co., representing the lessees, would not have anything to do with his suggestion. That statement had brought a certain amount of correspondence upon him (the speaker). As a matter of fact, the directors of the East London Co. had not been approached on the subject, directly or indirectly, but Mr. Perks, of course, meant the leasing companies and the Joint Committee. He (the speaker) held no brief for the lessees; he was only anxious that the improvement should be carried out, and he did not care who bore the cost—he meant, as chairman of the East London Co. He thought, however, that the importance of the question, as to who bore the cost, was exaggerated, as all probabilities pointed to the suburban parts of all metropolitan lines being electrically worked before long, and in that case all who used the installation would bear their proportion of the cost; but it did not seem to him an unreasonable proposition that, in the first instance, those who desired to use the line electrically should bear the cost. If the installation were made, the only benefit it could confer on companies not using the electrical method of traction would be that they would get their proportion of 44 per cent. of the increased traffic towards their loss on working expenses. He agreed, however, with the Metropolitan and District Cos., that if they electrified their line, and not the East London Railway, the present method of working would really become impossible; indeed, he did not see how those companies could afford this company "facilities," as they were bound to do by statute, "for the interchange and facilitating of through and other traffic." In his opinion the proprietors in the East London Co. need feel no undue anxiety as to the deadlock. He looked for substantial advantage to the company from the adoption of electric traction, which he thought was certain in the near future.

Germany.—It is proposed to construct an electric tramway between Hademarschen and Fishcherhütte (Holstein), for the rapid conveyance of goods to the Kaiser Wilhelm canal.

Glasgow.— Councillor Russell has given notice of motion that the general manager of the tramways be instructed to make up a statement showing separately each week for two weeks, the revenue and earnings per car-mile of the different stages in all the tramway routes on the city's system. The idea is to discover the portions of the different routes which do not pay.

Glasgow and South-Western Railway.—This railway company is seeking powers to construct about 6 furlongs of new lines, to widen about 4½ miles of its existing lines, and to enable it to at any time work by electrical power the traffic on its railways.

G.E. Railway and Electric Traction.—Speaking at the half-yearly meeting of the Great Eastern on 27th ult., Lord Claud Hamilton referred at some length to the possibilities of electrification. He said: "In their suburban traffic, the greatest pressure arose at Walthamstow, where between 7.50 a.m. and 7.59 a.m.—nine minutes—they had to move nearly 5,000 passengers to London, and to do this they ran five trains with seating capacity for 4,200 people. He would compare that with two specimens of the electrical system—the Central London and the Manhattan Railway of New York. The former during their busiest time ran five trains at about 2¼ minutes' interval with seating capacity for 1,620 passengers, whilst the latter ran trains at 1½ minutes' interval, which in 10 minutes would give a seating capacity of 2,016 passengers. It would, therefore, be seen that they were able in their busiest period to provide about twice as many seats as either of those two electrical railways. Now, the main trouble arose from the fact that the class of passengers carried by these trains would crowd into the latest trains. They had tried to increase the number of trains by obtaining greater acceleration by means of engines of the Decapod type. The experimental Decapod engine built at their works realised anticipations, but they found that, in order to obtain in every respect the speed desired, it was necessary somewhat to add to the weight upon the wheels, and when that came to be fully considered it was found that it would be necessary to expend a much larger sum than was originally contemplated upon strengthening the bridges in the suburban district. They shrank from any very large expenditure in that direction at the present moment, especially having regard to the possibility of electricity in the future, and, therefore, instead of building more engines of the Decapod type, they had for the present, so far as they were able, solved the difficulty in another mode. The Decapod engine would not be in any sense wasted, but would be utilised at reduced weight for other purposes. They had, therefore, issued instructions for the platforms of the lines most liable to be crowded, to be lengthened, so as to enable the trains during the busiest hours to be composed of 17 instead of 15 coaches, increasing the seating accommodation by an average of about 120 per train, or about 15 per cent. In the present transition stage of electrical development, in his opinion, it would be suicidal policy to embark in vast capital expenditure which, after a brief period, might prove to be of little value either to the shareholders or to users of the line."

Halifax.—At a recent meeting of the Electrical Committee, Mr. Thomas Cheetham appeared before the Committee and explained the working of a device for cutting off the electric current in case of the breaking of the wires, and it was resolved that Mr. Cheetham be allowed to fix his device on the Brighouse section at his own cost, on condition that he undertook to remove the same at the end of 12 months, and to take all risks in connection therewith.

The Electricity and Tramways Committee is considering the question of running single-decked cars.

Harrow and Uxbridge Railway.—Colonel Mellor told the shareholders of this company on the 29th ult. that the railway would be ready for opening in April, when it would be worked by the Metropolitan Co. It was not proposed to work the line electrically at first; steam traction would be used for a time. The electrification arrangements are well in hand, and will be ready by the time electrical working is introduced on the Metropolitan.

L. and Y. Railway.—Electrical engineers will note with interest an attempt which is being made by the L. and Y. Railway to obtain a better suburban service, apart from its use of electric traction on the Liverpool and Southport line. The *Times* says that the company, "in order more satisfactorily to cope with its heavy suburban trains, has just introduced the first of an entirely new series of powerful tank locomotives. This engine, No. 404, is of large proportions, having precisely the same boiler dimensions as the eight-wheeled coupled goods engines introduced on the Lancashire and Yorkshire Railway some few months ago, and has been erected at the company's works at Horwich from the designs of Mr. H. A. Hoy, the chief mechanical engineer of the railway. The engine will, it is expected, give rapid 'acceleration' and at the same time maintain a high average speed. The cylinders are 19 in. in diameter, with a stroke of 26 in. The boiler has a total heating surface of 2,038·64 square feet. The leading and trailing wheels are 3 ft. 7⅝ in. in diameter, whilst the six coupled wheels are 5 ft. 8 in. in diameter. The bunker has a capacity of 3¾ tons of coal and 2,000 gallons of water, and an improved apparatus for taking in supplies of water from the track troughs whilst travelling in either direction is provided. The engine in working order weighs 77 tons 10 cwt. 1 qr." In this connection the G.E. experience, as related above, is significant.

Lancaster.—The Scotforth route is 1·5 miles, and was opened on January 14th, 1903. The total number of passengers carried during the year was 795,657, and the cash receipts were £2,844. The Park route has carried since April 8th, 1903, 317,707 passengers, the receipts being £1,440. The receipts are £4,284.

Liverpool.—The receipts from the Liverpool tramways for the past year were, from traffic, £524,468; total, £531,483. A balance on net revenue account of £190,000 remained for distribution. Out of this it is proposed to carry £53,560 to sinking funds, to mortgage and cancellation of debt; £53,453 to interest on loans, and £32,080 to the general rate, in addition to £2,000 contributed to the city fund. £64,161 will be carried to reserve, renewal and depreciation account. The estimated expenditure on revenue account for the current year is £470,490.

L.B. and S.C. Electrification.—Speaking at the half-yearly meeting last week, Lord Cottesloe, the chairman, referred to the question of electrification. The introduction of some system of electrical working, he said, might possibly prove to be one way of dealing with competition from rate-aided tramways, &c., at any rate so far as suburban and short-distance traffic were concerned. But it was necessary to mention only two of the many difficulties which had to be solved in order to show how desirable it was to proceed with the utmost caution. In the first place, a very large outlay of capital would necessarily be required, if only a short length of line were equipped, and the rapid advance which was being made, almost from day to day in electrical science, rendered it at least possible that any system adopted might in a short time become out of date, and have to be superseded at a further heavy cost. Then there was the question of how to deal with the rolling stock which would become unnecessary if electrical working was adopted on any substantial scale. The board, however, was giving attention to the subject, and it had the advantage of a practical electrical engineer as one of its members, and of being advised by an eminent consultant, who had recently made a special inquiry into the best-known systems of working. Until a system likely to prove permanent in character, and economical in working, had been found, the board would not incur any serious expenditure on that account.

London.—L.C.C.—At the meeting on Tuesday, the Highways Committee presented a report relating to the contemplated conversion to electric traction of the tramways at present leased to the North Metropolitan Co. It appeared that in accordance with a decision of the Council last December, plans illustrating the proposed conduit system to be employed on a portion of the lines had been forwarded to the Board of Trade the local authorities and the tramway company. The plans were now under the consideration of the Board of Trade, which had before it various suggestions from the local authorities as to the details of the system, and the manner in which the work should be carried out. A communication was sent to the company asking whether they desired to submit any suggestions in regard to the manner in which the work should be undertaken in order to minimise any inconvenience, whilst the work was in progress. A reply had been received stating that until the company were in possession of certain further information with regard to the working of the conduit system, they considered "that the time has not arrived when they can with advantage to themselves or the Council make, as they are invited to do in your letter under reply, any suggestion to the Council in respect to the adoption of the underground system of electric traction on any of the Council's northern system of tramways now leased to the company." The Highways Committee proceeded to state that the history of the past negotiations with reference to this matter, indicated clearly how difficult it was to reconstruct the northern tramways if the company were not prepared to accord full assistance and co-operation in the work. Nevertheless, the Council was under an imperative duty to do all within its power to expedite the adaptation of the lines for electric traction, and it was hoped very shortly to submit definite proposals to enable the reconstruction of the first section of the tramways to be commenced at an early date. With regard to the employment of overhead traction on portions of the lines, the Committee reported after communicating with the 10 borough councils concerned, that eight of the local authorities were opposed to the adoption of this system, one authority had expressed qualified approval of the Council's proposals so far as it was affected, while no definite opinion had been expressed by the other local authority concerned. They had under consideration the question of the course which in the circumstances should be adopted in view of this expression of opinion as to the use of the overhead trolley system where it appeared to be necessary, and proposed also to report at an early date with regard to the question of the reconstruction of the other lines, on which it is proposed to install the conduit system.

The Highways Committee of the Greenwich B.C., in a report issued on Tuesday, approve of plans submitted by the L.C.C. for the erection of a generating station to abut upon Old Woolwich Road.

Manchester.—The poll of the citizens on the Corporation Tramway Bill, which is being strongly opposed by the Horse Owners' Association and by the general body of carriers, took place on Friday last. There voted for giving authority to the Corporation to proceed with the Bill, 8,096; against, 1,284—majority, 6,812.

A hundred new electric cars, of the bogie type, have been ordered by the Tramways Committee.

At last week's meeting of the Committee, the Negotiations Sub-Committee reported that they had had an interview with the Ashton-under-Lyne Corporation, and had cleared up all the outstanding points of difference between the Corporations with one exception. They hoped the agreement would shortly be signed, and that a through car service between Manchester and Ashton would be established at an early date.

Morley.—The T.C. has received a letter from the B.E.T. Co., stating that the directors regretted that they were at present unable to fix a date for the commencement of the light railways in Morley and district. The other lines which had been constructed in Yorkshire had not proved remunerative, and it was not possible, therefore, in the present depressed condition of the money market, to raise capital upon sufficiently favourable terms to justify proceeding with the undertaking at present. The directors, however, hoped that it would not be long before financial conditions improved, so as to justify them proceeding with the lines.

Musselburgh.—The T.C. has had before it a report by Mr. Sayers, of Westminster, on the "G.B." surface-contact system. The report was favourable to the system, and was adopted. In the course of the discussion it was pointed out that, if the Council purchased the undertaking, and it did not prove successful, it would have the right to revert to another system.

Newcastle-on-Tyne.—It has been decided to take a poll of the inhabitants of the city in respect to those portions of the Corporation Bill, 1904, which deal with the extensions of the tramways and the purchase of the Scotswood Bridge Co.'s undertaking. In connection with this poll, Mr. Cail, chairman of the Tramways Committee, has issued a very lengthy statement on behalf of the Committees concerned, of the facts of the proposal. The contention of the Committee is that the extensions are desirable, and past experience suggests that they will be profitable. The proposal to purchase Scotswood Road and the Bridge will involve an outlay of £36,300. The company has agreed to sell on the basis of a 25 years' purchase—or a 4 per cent. basis—and as for the past 40 years the average dividend has been over 7 per cent., the Committee claims that the bargain is a good one, even apart from the question of the tramways. The Corporation is at present owner of $\frac{1}{10}$th of the company's shares. There is opposition to the proposal to extend the tramways beyond the city boundaries.

Paris.—A Government Committee, which has been inquiring into the question of tramway communication, shows that, out of ten companies, five do not earn sufficient to cover working expenses. It is recommended that an entire reorganisation of the service be arranged. Among other ideas is the cancelling of the concessions of the companies which cannot meet expenses.

There has been a strike among the employés of the East Parisian Tramways Co.

St. Helens.—The Corporation has decided to reconstruct a portion of its tramways at a cost of £6,000.

Salford.—Our Manchester correspondent writes:—"The financial prospects of the Salford borough tramways are causing some anxiety to the Tramways Committee and the management. As a result of the year's working, the Committee were able last year to contribute £10,000 in aid of the rates, and the outlook was then so promising that a contribution of £12,000 during the present year was promised. The result of the first half-year's working was satisfactory, and the Committee hoped to be in a position to fulfil their promise. This is now, however, more than doubtful. It is not improbable that the rates will fail to receive any benefit at all. One cause of this is said to be an unaccountable falling away of the traffic receipts since August last, added to the increased capital charges consequent on further developments, and the outlay of £40,000 on additional cars. At midsummer last year the receipts reached £19,000 per month—a figure not since touched. The average since June has been £18,000 per month. The decline since August has been steady, the lowest monthly receipts being those for November, when they were £16,400, the average being about £17,000, whilst the consumption of current has rapidly increased through the necessity of lighting the cars, in dull weather, during a great part of the day. The cost to the Tramway Committee for current rose from £2,900 in August to £3,800 in November. As a matter of fact, it is said, instead of maintaining an approximate profit of £500 per week, as in the first half of 1903, the decrease of receipts and increased expenses together have resulted in a slight loss for some weeks past. This has occurred in face of the fact that whereas formerly only some 90 cars were in use, there are now over 100. Complaint is made by the Tramways Committee of the price for current charged to them by the Electricity Committee. The cost for traction amounts to £20,000 per annum more than would require to be paid by a private tradesman using current for lighting or power. They claim that but for this burden they would be able to show results proportionately equal to those of Manchester. A conference between the Electricity and Lighting Committees of the Corporation may ultimately lead to a better understanding. It seems unfortunate that the tramway undertaking should appear to make so little progress towards financially good results; but the Electricity Committee do not, in present circumstances, see anything they can do to avoid it. The Manchester sections worked by Salford (Deansgate, Bury New Road, &c.) are supplied with current by Manchester at a fraction over 1d. per unit. in place of the 2d. (less 2½ per cent.) charged by the Salford Electricity Department for the general tramways of the borough."

Switzerland.—The municipal authorities of Schaffhausen have approved of a project for the construction of an electric tramway between that town and Schliethein, at an estimated cost of £44,000.

Wallasey.—On Saturday the ratepayers were polled with respect to the proposed Tramways and Improvement Bill. The result showed that 1,635 were in favour of the Bill, and 2,517 against. The poll was a small one, there being 11,500 electors in the district. The District Council was almost unanimously in favour of proceeding with the Bill. The result on Saturday was the second defeat which the project had suffered at the hands of the ratepayers.

West Bromwich.—An unfortunate dispute has arisen between the Corporation and the South Staffordshire (Lessee) Co. respecting the operation of the electric tramways within the borough. The points of difference relate to finance, the using of the late Mr. Quin's "cut-outs," the construction of the tramways, and other matters. The tramways within the borough were purchased by the Corporation from the Staffordshire Co., and, after being reconstructed and electrically equipped, were leased to the South Staffordshire (Lessee) Co. The latter, it is understood, agreed to repay by instalments the amount expended by the Corporation in the work of reconstruction, together with rent and interest upon the capital at a fixed rate. Further, the lessee company, so it is said, agreed to purchase their supply of electric current from the Corporation electricity-generating works. Recently, it is stated, the points mentioned above have arisen, and hints have been made of a probable deadlock. A conference has taken place between Messrs. Garcke and Lycett, as representatives of the company, and members of the Town Council, but it came to an end without any result. Another conference has been arranged to be held shortly.

TELEGRAPH AND TELEPHONE NOTES.

Liverpool—Emden Telegraph Service.—The Liverpool Chamber of Commerce, recognising that telegraphic traffic between Liverpool and Emden has considerably increased during the last two years, has resolved to write to Lord Stanley and ask whether he can negotiate with the German Administration for the establishment of a direct telegraphic wire between Liverpool and Emden.

Telegraphic Interruptions and Repairs :—

Cables.	Interrupted.	Repaired.
Dominica-Martinique	May 5, 1902	
St. Lucia-Martinique	May 7, 1902	
St. Lucia-St. Vincent	Sept. 19, 1902	
Trinidad-Demerara No. 1	Aug. 27, 1901	
Mole St. Nicolas-Port-au-Prince	Dec. 16, 1903	
Cayenne-Pinheiro	Aug. 18, 1902	
Paramaribo-Cayenne	Feb. 26, 1903	Jan. 28, 1904
New York-Hayti	April 18, 1903	
Anjer-Kalianda	Aug. 2, 1902	
Reissa-Issa (Yemen)-Camaran	Oct. 22, 1902	
Tourane-Amoy	Nov. 10, 1903	
Tarifa-Tangier	Jan. 18, 1904	
Landlines.		
Swakopmund-Windhuk (beyond Karibib)	Jan. 20, 1904	
Indo-European: Odessa-Kertsch	Jan. 28, 1904	Jan. 28, 1904

International Telegraphy.—The Netherlands Indies Office announce the opening to the International service of cables from Pangkalpinang (Banka) to Tandjoeng Pandan (Billiton), and from Tandjoeng Pandan to Pontianak (Borneo), with offices at Tandjoeng Pandan and Pontianak.

CONTRACTS OPEN AND CLOSED.

OPEN.

Battersea.—February 15th. 750-kw. steam dynamo, electric pumps and pipework. See "Official Notices" January 29th.

Bedford.—February 9th. Switchboard for electricity works. See "Official Notices" January 29th.

Bermondsey.—February 16th. Lamps, carbons, meters, cables, oils, &c., for one year. See "Official Notices" to-day.

Camberwell.—February 16th. Engine and dynamo for the Baths. See "Official Notices" to-day.

Canterbury.—February 8th. Four motor-driven pumps. See "Official Notices" January 22nd.

Chili.—June 28th. Tenders are being invited for the public electric lighting of the city of Punta Arenas (Straits of Magellan), which will be opened on June 28th next, at 2 p.m., in the offices of the Municipal Commissioners of that city. Full particulars can be obtained on application to the Chilian Legation, 29, Queen's Gate Terrace, S.W.

Edinburgh.—February 22nd. Engine and dynamo of large size. See "Official Notices" January 22nd.

Hammersmith.—February 10th. General stores for the electricity department. See "Official Notices" January 29th.

Islington.—February 25th. Stores for the Electricity Department. See "Official Notices" to-day.

Hanley.—February 22nd. 500-kw. steam or turbo-alternator, condensing plant, superheaters, &c., for the electricity works. See "Official Notices" January 29th.

Hornsey.—February 8th. Two dryback boilers, smoke consuming apparatus, 100 and 300-kw. steam dynamos, motor-generators. See "Official Notices" January 8th.

Horwich.—February 6th. Electric light installation for certain hospital buildings of the Horwich, Westhoughton and Blackrod Hospital Committee. Messrs. Cressey & Keighley, architects, Euston Road, Morecambe.

Islington.—February 17th. Free wiring, and motor hiring. See "Official Notices" January 29th.

Islington.—February 24th. Conduits and mains. See "Official Notices" January 22nd.

Leeds.—February 10th. Electric wiring for the branch library, Wesley Road. Specifications from town clerk (one guinea).

L.C.C.—February 9th. The Council is prepared to receive tenders for the supply and delivery of eight railway turntables, and for the erection of the same at the Council's generating station, Greenwich. Specification, &c. (£2), at the County Hall, Spring Gardens, S.W.

Manchester.—March 1st. The Manchester Dock and Warehouse Extension Co. wants tenders for 25 electric hoists and 10 electric fixed cranes. See "Official Notices" January 29th.

Mersey Railway.—The company is inviting tenders for 12 months' stores. See "Official Notices" to-day.

Preston.—February 15th. Feeder mains. See "Official Notices" to-day.

South Shields.—March 12th. The Corporation invites offers for the lease of certain tramways. See "Official Notices" January 15th.

Spain.—February 12th. Concession for an electric tramway between Porrino and Mondariz (Pontevedra province). See "Contracts Open" December 18th.

Spain.—February 15th. The Public Harbour authorities at Barcelona are inviting tenders until February 15th for the contract for the establishment of the plant and equipment for the electric lighting of the sheds at the Port of Barcelonnette, and for the operation of the cranes, travellers, &c.

Spain.—March 21st. Tenders are being invited until March 21st by the Spanish Ministry of Public Works in Madrid for the concession for the construction and working of an electric tramway in the town of Seville. Tenders are to be sent to La Direccion General de Obras Publicas, Madrid, whence particulars may be obtained.

Stockton-on-Tees.—February 16th. A year's stores for the electricity department. See "Official Notices" to-day.

Sunderland.—February 26th. Crane and battery. See "Official Notices" January 29th.

Swindon.—February 15th. Electric wiring of a school. See "Official Notices" January 29th.

West Ham.—February 11th. Stores, cable, recording wattmeters, cut-out boxes, transformers, incandescent lamps, and coal for the electricity department. See "Official Notices" January 22nd.

CLOSED.

Newcastle-on-Tyne.—The Tramways Committee of the T.C. has accepted the tender of Messrs. Bolckow, Vaughan and Co., of Middlesbrough, for the supply of tram rails at £5 4s. 9d. per tons.

Chesterfield.—The Corporation has ordered from the British Westinghouse Co. a 400-kw. steam dynamo, together with switchboard and auxiliary apparatus, a Babcock & Wilcox boiler, and a Worthington jet condenser.

Chiswick.—The following tenders were received by the U.D.C. for a refuse destructor and auxiliary plant. The estimate of the consulting engineers, Messrs. Swinburne, Cooper & Baillie, was £6,000:—

Horsfall Destructor Co.	£5,837
" " with Custodis chimney (*accepted*)	5,637
Goddard, Massey & Warner	7,470
Heenan & Froude, Ltd.	6,924
Meldrum Bros.	6,541
Refuse Destructors, Ltd.	5,584
Hughes & Stirling	5,214
W. F. Mason, Ltd.	3,336
Joseph Baker & Sons (part only)	2,900

The Council has also accepted the tender of the Horsfall Co. for additional works, making a total of £7,481.

Dewsbury.—The Electricity Committee has accepted the tender of Callender's Cable Co. for the supply of certain cable, and the Maxim Engineering Co., Ltd., for the supply of steam piping, at £245.

Fife Electric Power Co.—This company has accepted the tender of Messrs. Bruce Peebles & Co., Ltd., for generating machinery (Dumfermline Station) engines, alternators, boilers, switchgear, &c. (2,000-H.P.), £23,590.

Sydney (N.S.W.).—Messrs. W. T. Henley's Telegraph Works Co. have secured the contract for supplying and laying cables (including three-phase cables) for the Sydney tramways.

Tiverton.—The British Westinghouse Co. are supplying two gas engines and auxiliaries to the Corporation, through Messrs. Frank Suter & Co. These engines are of 125 B.H.P. each, and are of the three-cylinder (15 in. by 14 in.) type.

Todmorden.—The Corporation has placed the contract for the storage battery with the E.P.S. Co., Ltd.

Messrs. Siemens Bros. & Co., Ltd., have placed the contract for the storage battery for Pembroke Dockyard with the same company.

The storage battery contract for the Haslar Hospital has also been placed with the E.P.S. Co. by Messrs. Bergtheil & Young.

FORTHCOMING EVENTS.

Friday, February 5th.—At 8 p.m. Junior Institution of Engineers. Westminster Palace Hotel. "Producer Gas Power for Factories, Cold Stores, and Freezing Works," by Mr. H. Williams.

Saturday, February 6th. — Institution of Electrical Engineers (Glasgow). Annual Smoking Concert at Grand Hotel.

At 7.30 p.m. Glasgow Technical College Scientific Society. Twelfth Anniversary Dinner.

At 10 a.m. Institution of Electrical Engineers. Students' visit to the Tunnelling of the Baker Street and Waterloo Railway, at Messrs. Mowlem & Co.'s Contract Works, Lambeth Road.

Monday, February 8th.—At 8 p.m. Engineers' Club. Bohemian Concert at Westminster Palace Hotel.

Institution of Mechanical Engineers (Graduates). "The Work of the Alloys Research Committee," by Mr. W. H. Merrett.

Tuesday, February 9th.—At 8 p.m. Institution of Electrical Engineers (Glasgow). Meeting.

Wednesday, February 10th.—At 8 p.m. Liverpool Engineering Society. Mr. E. K. Scott on "Electric Transmission from Water-Powers."

At 8 p.m. Association of Engineers-in-Charge. "Gas Engines," by Mr. Horace Allen.

At 8 p.m. Society of Arts. "Thermit: Its Application to Metallurgical Engineering," by Mr. Charles V. Boys, F.R.S.

At 7.30 p.m. Institution of Electrical Engineers. (Students.) "On Small Private Installations," by Mr. H. Purle.

Thursday, February 11th.—At 8 p.m. Institution of Electrical Engineers. Meeting at I.C.E. "Trans-Atlantic Engineering Schools and Engineering," by Prof. R. M. Walmsley.

Friday, February 12th.—At 8 p.m. Physical Society. Annual general meeting at the Royal College of Science, S.W. Dr. R. T. Glazebrook, F.R.S., will deliver his presidential address.

At 8 p.m. Institution of Civil Engineers (Students). "The Electricity and Destructor Station at Plumstead," by T. S. Nash.

Saturday, February 13th.—At 6.30 p.m. Junior Institution of Engineers. Dinner at the Hotel Cecil.

Monday, February 15th.—Electrical Engineers' Ball at the Hotel Cecil.

NOTES.

Funeral of the Late Mr. W. G. McMillan.—Yesterday, at noon, a memorial service was held at St. Leonard's Parish Church, Streatham, prior to the cremation, which took place at Golder's Green Crematorium. The service was conducted by the Vicar. Besides the relations and personal friends of Mr. McMillan, a number of members of the Institution of Electrical Engineers were present, including the President, Mr. R. K. Gray, Major-Gen. Webber, Col. Crompton, Profs. J. A. Fleming, R. H. Smith and S. P. Thompson, Messrs. W. R. Cooper, J. Gavey, R. Hammond, H. E. Harrison, J. E. Kingsbury, W. M. Mordey, A. Moir (Newcastle), W. H. Patchell, F. C. Raphael, J. H. Rider, J. Wetzler, E. Worthington (Sec. Inst. Mech. Eng.), P. F. Rowell, R. Tree and A. Tree (members of the staff), and other gentlemen.

Engineering Standards Committee: Electrical Conference.—We are informed that the Electrical Conference, which was convened by the Sub-Committee on Generators, Motors, and Transformers, took place at the Institution of Civil Engineers on Tuesday and Wednesday the 26th and 27th of last month, and was extremely well attended, all the leading manufacturing firms being represented, and many consulting engineers being present. A list of questions had, previous to the Conference, been drafted and circulated to those gentlemen who proposed to attend the Conference, in order that they might be more exactly informed as to the precise matters to be discussed.

In his short opening address, the chairman (Col. R. E. Crompton, C.B.) referred to the opinions which had been expressed on the recommendation of the British Engineering Standards Committee with reference to standard frequencies, and remarked that the Committee had for this, and for other reasons, decided upon holding this Conference. A very animated discussion took place upon the different matters referred to in the list of questions before the meeting, which did not break up till late in the afternoon of the first day. On the second day the several knotty problems arising out of the Committee's proposals for standardising motor carcases and speeds were dealt with at length.

We understand that the very interesting and instructive discussion which took place, with regard to both the question of standard frequencies and that of motor standardisation, will have great weight in any recommendations which the Committee may make in the future with regard to these important matters.

The Chairman, after thanking those present, many of whom had come a considerable distance to attend the Conference, informed the meeting that the Committee intended, at an early date, to carefully consider all the different points raised by the several witnesses present. In conclusion, he added that with the aid of the valuable information so courteously placed at the disposal of the Committee, he felt sure they would be very greatly assisted in the object they had in view, namely, the benefiting of the Electrical Industry of the British Empire by judicious standardisation.

Electricity in Coal Mines.—In regard to our leaderette of last week, a correspondent writes drawing attention to another development in the use of electricity for mining. His point is that although electricity is used to a very large extent for "coal getting," the use of electrical coal cutters at present represent an extremely small percentage of the total number of machines used, and by far the larger majority of them are compressed air tools of the percussive type. He says:—"Even when rotary cutters are used there are many more of the compressed air type, *i.e.*, driven by compressed air engines, than of the electrically-driven type, in use in British coal fields at the present time. It will probably be correct to say that in a large majority of English coal mines electrically-driven coal-cutters could not be used at the working face, on account of the great danger of sparking. On the other hand, there is no reason at all why the electrical engineer should retire from the field on this account, because there is another way in which he could attack the problem, with advantage to the electrical industry. I refer to the system of driving air compressors by electric motors, splitting up the electrically-driven compressors into small units, which can be placed as near to the working face as the working conditions in any particular colliery will allow, and conveying the air from these electrically-driven machines through short pipes to the coal cutter of the pneumatic type, whether rotary or percussive, which may be in use at the working face. An electrically-driven air compressor can be placed relatively close to the working face, but yet be quite free from any danger from sparking, because it could be put in a small chamber cut in the side of one of the roads, where there is plenty of ventilation. As compared with the present system of using a large steam-driven air compressor on bank, and conveying the air to the pneumatic tools through long lines of air pipe, there is no doubt that this system is destined to meet with great favour. It is perhaps needless to point out that the electrical energy can be conveyed from a high speed engine and dynamo on bank to the electrically-driven compressors below with far greater efficiency than is obtained in the transmission of compressed air through long lines of air piping. Furthermore, the ordinary type of electric lighting engine, as it is now made, is without doubt more economical in steam consumpton that the ordinary type of steam-driven air compressor, so that the system we have outlined above gives greater economy in the production of power, greater economy in the transmission of the energy, and at the same time enables the use of the ordinary rotary or percussive pneumatic tools for coal getting to be continued."

Determination of the Form Factor.—The ratio of the root mean square E.M.F. to the mean E.M.F. is an important so-called "factor"—the form factor—in the design of alternators, but its determination in the usual way by graphic methods is somewhat tedious. In predetermining the ratio, there is, of course, no better way; but when a machine of similar design is available, the form factor can readily be obtained by experiment. Messrs. Roze and Kühns have described, in the *E.T.Z.* a device for this purpose, consisting of a rectifying commutator driven by, or synchronous with, the machine in question. The terminals of the alternator are connected in series with the rectifier to a voltmeter having very low inductance, which will then obviously indicate the *mean* voltage. By this means, results have been obtained which differ from those of graphic methods by scarcely 0·3 per cent.

Electrical Vehicles in Spain.—Application has been made for a concession to establish and work a public service of electric motor vehicles between Pamplona and Villars, the cars taking their current from an overhead conductor.

(*Continued on page* 225.)

IN MEMORIAM.

Walter G. McMillan.

It is with deep regret that we find ourselves writing a last tribute to the memory of Walter G. McMillan, who passed away at Streatham last Sunday evening; and it is no meaningless phrase to say that he will be universally mourned by members of the Institution of Electrical Engineers, and by the engineering profession at large. It is only a little more than a fortnight ago that he was at the Institution, and appeared in good health. Then it became known that he was suffering from an attack of pleurisy; but the latest news was reassuring in every way. The pleurisy had passed; professional care was not so necessary; in fact, the convalescent stage had been reached, and it was expected that in a few days he would be about again, though not at work. This was so on Sunday afternoon; yet some hours later there came an attack of heart failure, and in a few moments all was over.

Photo. by] *[Elliott & Fry.*

THE LATE WALTER G. McMILLAN, F.I.C., F.C.S., SECRETARY OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

Mr. McMillan was born on January 3rd, 1861, and was educated at King's College School, passing subsequently into King's College. Here he became a prominent student, and was awarded the Daniell scholarship in 1880 as the result of a research on the effect of the electric spark on mixtures of oxygen and nitrogen. At the end of his college course he gained an insight into business methods by working for a year in an accountant's office, after which he returned to scientific work, and joined the staff at King's College, assisting Prof. Thomson in his lectures at Queen's College, and becoming Demonstrator of Metallurgy at King's. His interest in students' affairs was shown by his being President of the Students' Scientific Society; indeed, he was an excellent organiser of all students' societies which had pure and applied science for their object. Nor was his energy restricted to college surroundings, for he did a large amount of most valuable charitable work, which was not known to any but his most intimate friends. He also held scientific evenings for poor boys, and gave lectures on applied science, following these up with competitions, for working men.

In 1888 Mr. McMillan was appointed by the Indian Government for five years as chemist and metallurgist to the Cossipore Ordnance Factories, near Calcutta. While in India he acted as Examiner in Chemistry to the University of Calcutta, and was also appointed as a Municipal Commissioner of Cossipore-Chitpore, a manufacturing suburb of Calcutta.

Upon his return from India, Mr. McMillan was appointed to a Lectureship in Chemistry at Mason's College, Birmingham; and about this time he turned his attention more to literature. He had already written with Prof. Huntington the book on "Metals" in Longmans' "Text-Books of Science" Series; but having since that time paid attention to electrical methods, he wrote in 1890 a "Treatise on Electro-Metallurgy"; and in 1897 he translated Dr. Borchers' book on "Elektro-Metallurgie," adding notes thereto, and calling it "Electric Smelting and Refining," a fresh edition of which is at the present moment in the press. He also contributed the articles on Electro-Chemistry and Electro-Metallurgy in the recently issued supplement of the "Encyclopædia Britannica." He was an abstractor of the Society of Chemical Industry, a Fellow of the Chemical Society and of the Institute of Chemistry, a member of the Institution of Mining and Metallurgy; and in 1897 he was elected Vice-President of the South Staffordshire Institute of Iron and Steel Works Managers.

So far Mr. McMillan was well known in the chemical world; but in 1897 he made a complete change in his life by accepting the post of Secretary of the Institution of Electrical Engineers, undertaking also the editing of the journal. The membership of the Institution was then less than 3,000, but since that time the membership has increased to over 5,000, and the work has quadrupled. There have also been many important changes, such as the formation of the class of

associate members, the inauguration of local sections, the introduction of foreign visits, the formation of sectional committees (a suggestion of his own), and the first effective steps in securing a home of its own for the Institution. These were apparent to all. But it was, of course, to those who saw the inner working of the Institution that the value of Mr. McMillan's work was most apparent. There never seemed too much work to be done. Even at the busiest times he was at the disposal of everyone, always tactful, always courteous. No detail was too small for his attention. If a difficult question had to be decided, every possible kind of information had been carefully prepared to aid the solution. Whatever was undertaken, whether a dinner, a concert, or a foreign visit, every detail was thought out before the event, and everything was sure to pass off with the greatest smoothness. Moreover, it was the result that was evident, not the man. In one respect this attention to detail was Mr. McMillan's one fault, for it made it almost impossible for the Council to relieve him of work as they wished; his extreme sense of duty made him delegate as little as possible to others, and he was always ready to take up more. It is easy to understand that the loss to the Institution is indeed a heavy one.

Last year Mr. McMillan was pressed to take a longer holiday than usual, from which he returned to the additional work of gathering up the threads of "Science Abstracts," the general management of which had been added to his other duties. He was devoting much of his untiring energy to this subject; it was, in fact, the last with which he was concerned. The Institution owes a debt of gratitude to him; for the work which his hand found to do he did with his might.

THE CABLE WORKS OF MESSRS. PIRELLI AND CO., MILAN.

Among the works of interest visited by the members of the Institution of Electrical Engineers during their tour in Northern Italy in April last, was the old-established factory of Messrs. Pirelli & Co., Milan, which is of considerable interest and importance, as it shows what our Continental friends have done to promote the cable industry.

It is well known that Messrs. Pirelli & Co. were the first on the Continent to manufacture submarine cables.

The manufactures of Messrs. Pirelli & Co. are many, and include india-rubber, gutta-percha and asbestos goods for every purpose, india-rubber and gutta-percha covered wires, and paper-insulated cables for power and telephonic transmission.

The manufacture of submarine cable is carried on at Spezzia.

The works at Milan cover an area of 360,000 sq. ft., of which 200,000 sq. ft. are covered with buildings. About 2,000 men and women are employed.

The power required to operate the works is 1,000 H.P., of which 400 H.P. is derived from steam engines driving independent heavy machines such as 3-roll calenders; the balance, 600 H.P., is taken from the Milan town electric supply, and actuates three-phase motors.

To facilitate the handling of goods, a network of narrow-gauge railway has been laid down between the buildings. Horses are occasionally used to haul the trucks.

Immediately on entering the works, the party saw a large stock of raw rubbers, among which were noticed Para and Peruvian rubbers used for electrical wires, Cameta, Negrohead and Mozambique used for mechanical goods.

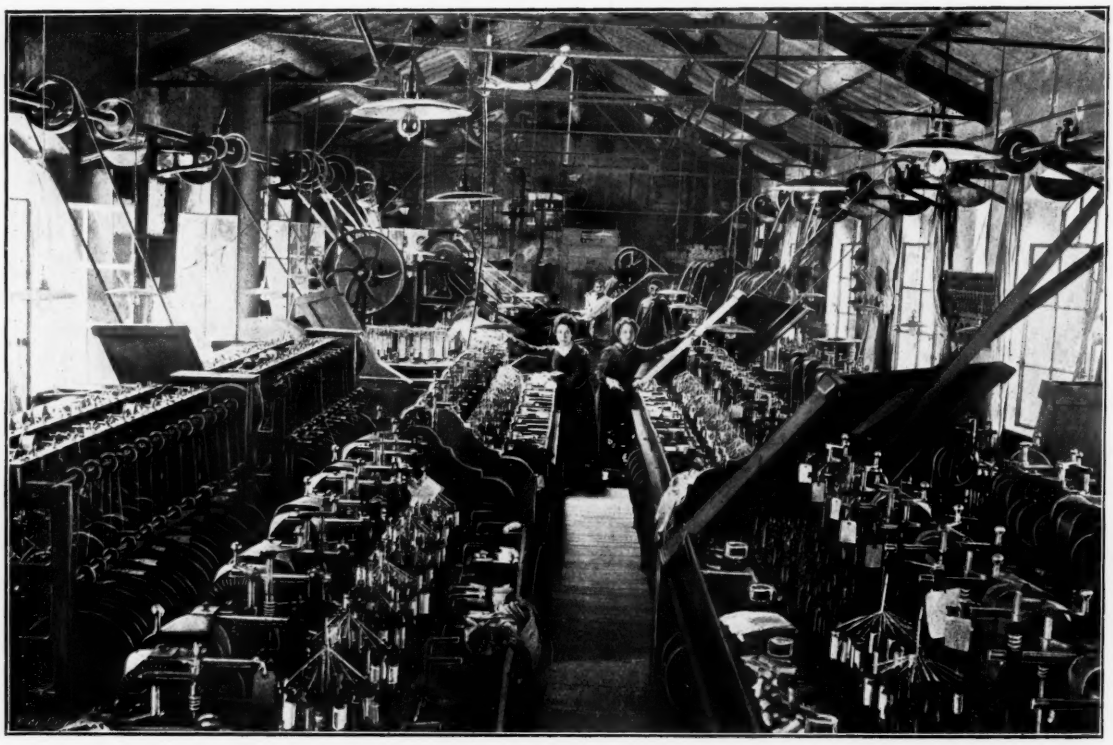


Fig. 1.—Messrs. Pirelli & Co.'s Cable Works.

Manufacture of Washed Rubber.—The raw rubber is placed in large tanks and boiled for a considerable time, and is then cut up into small pieces by means of a circular knife. These small pieces are passed through a washing mill which consists of differentially-speeded, serrated rolls which crush the rubber and form a rough sheet. While the rubber is being crushed between the rolls, water is continually played on them to remove sand and other deleterious substances which raw rubber generally contains. The rubber, after leaving the washing machine, is next passed through a sheeting mill, which is similar to the washing machine, but has smooth instead of serrated rolls. Water is played on the sheet as it passes through the sheeting rolls.

After being sheeted, the rubber is placed in a centrifugal drier which removes the excess of water, the last traces of moisture being removed in a vacuum-drying cylinder similar to the Passburg type, which is well known in this country. The dry rubber sheets are now in a condition to be mixed with French chalk, zinc oxide, sulphur, &c., to produce compound rubber articles, or to be used for the production of pure Para strip. Para strip can be made in three ways

(1) "spread sheet," (2) "cut sheet," (3) "calendered sheet."

Spread Sheet.—Dried Para is masticated between rolls until it assumes a homogeneous appearance, then small

Fig. 2.

quantities of naphtha are sprinkled over and thoroughly incorporated; the rubber is now in the form of rubber solution. This solution is taken to a spreading machine and spread upon a varnished cloth.

The spreading machine consists of a roll (over which the cloth passes) on which rests a knife; this knife is set to the desired thickness. After leaving the roll the spread cloth passes over steam chests, and the naphtha is evaporated leaving a sheet of pure rubber. The spread sheet is now hung up in a slow drying oven to remove the last traces of naphtha, after which it is soaked in water so as to enable the pure rubber to be removed. After removal the rubber sheet is wound on a spindle, placed in a lathe, and cut into strips. While cutting, water is played on the tool. The rubber strips are hung up to dry, and afterwards are wound into rolls.

Cut Sheet.—The masticated rubber is placed in a cylindrical screw press, and pressure is applied. After removal from the press the rubber cylinder is placed in a special machine and is cut longitudinally; the reciprocating knife is continually wetted. Special mechanism has been devised so that the sheet cut is of uniform thickness.

Calendered Sheet. — The masticated rubber is passed through a calender set at the required thickness, collected on varnished cloth, cut into strips, and packed ready for use.

Preparation of Compound Rubber for Wires.—The masticated india-rubber is mixed by means of differentially speeded rolls with zinc oxide, French chalk, sulphur, &c. The pigments are mixed in a separate room and are sent to the mixers in boxes. After thorough incorporation the rubber compound is passed through the calender set at the required thickness, collected on varnished cloth, and allowed to cool. The rubber is then removed from the cloth and cut into strips, and is now ready for use either on the longitudinal covering, or tube machine.

Manufacture of India-rubber Wires and Cables.—The conductors are either single or stranded tinned-copper wires. In some cases, however, a plain wire strand lapped with tinfoil is used. The conductor is first covered with a lapping of pure rubber prepared by one of the above-mentioned methods. Compound rubber is next applied by means of the longitudinal covering, or tube machine. A lapping of waterproofed tape is then applied, and the cable is ready for vulcanising.

The vulcanising process is as follows:—The covered wires are wound on cylinders and placed in a heater, into which live steam is allowed to enter at a given pressure.

The time that the wire is left in the heater depends upon the quality of the material used.

After vulcanising, the wires are wound into coils or on drums, and are placed in a water tank and left there for 24 hours, after which they are tested for insulation resistance, capacity, and conductor resistance. After being tested and found satisfactory, the wires are braided and compounded. The braiding machines are shown in figs. 1 and 2. High speed silk-covering machines are to be seen in the left of fig. 1.

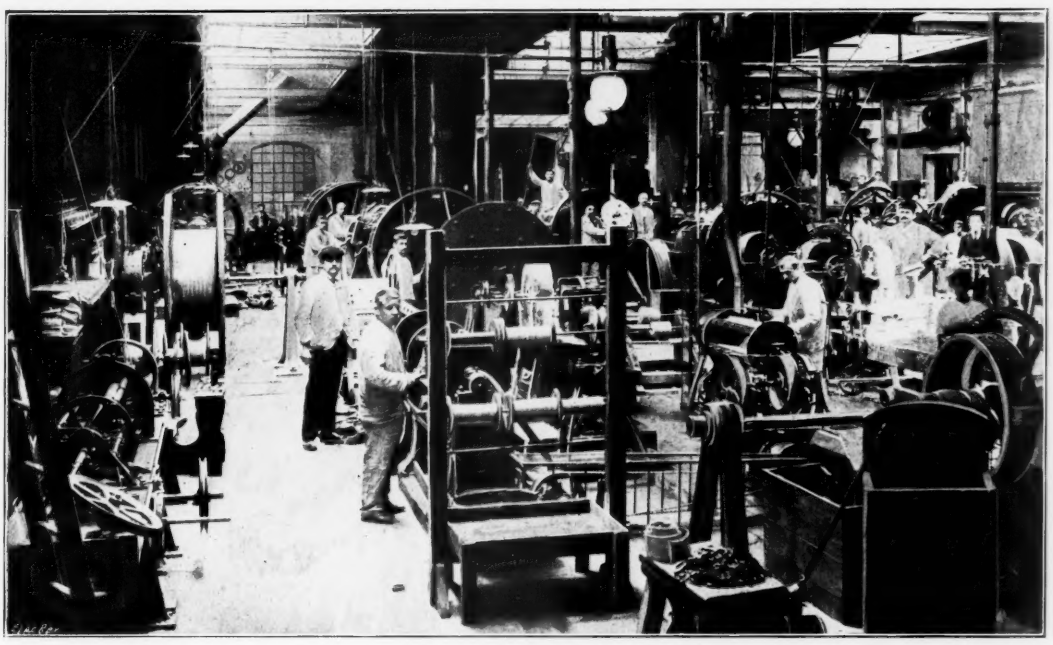


Fig. 3.

Manufacture of Dry Core Telephone Cables.—Copper wire is covered with a lapping of paper by machines shown in the foreground of fig. 2. Two conductors, one covered with white paper, and one with red, are twisted together; these twisted conductors are next placed in a large stranding machine, shown in the left of fig. 3, and cabled up in reversed layers. A lapping of paper is placed over the core, and the cables are then taken to the drying cylinders and dried under vacuum. The cables are lead covered by a lead press similar to the one shown in fig. 4. They are then tested under water at a pressure of 75 lbs. with dry air, after which the usual capacity, insulation and conductor tests are taken.

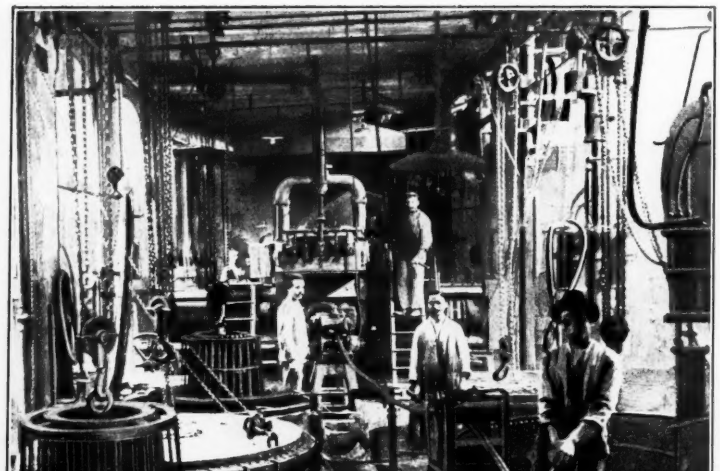


Fig. 4.—Messrs. Pirelli's Cable Works.

It may here be mentioned that the whole of the cables for the Milan telephonic system were made by this company.

Manufacture of Electric Light Cables.—In fig. 3, stranding machines to lay up the copper wires are seen. The copper conductors are first covered with a cotton gauge tape, and then are covered either with strips of paper or with jute, wound on cylinders (see fig. 4), and placed in drying tanks and dried under vacuum. After the cables have been dried for some time, the impregnating liquid is allowed to enter until the tank is nearly full, the vacuum still being maintained for some hours. The vacuum pumps are of two types:—(*a*) direct steam driven; (*b*) belted to a motor. The cables are then run from the tanks, as can be seen in fig. 4, to the lead press and lead covered.

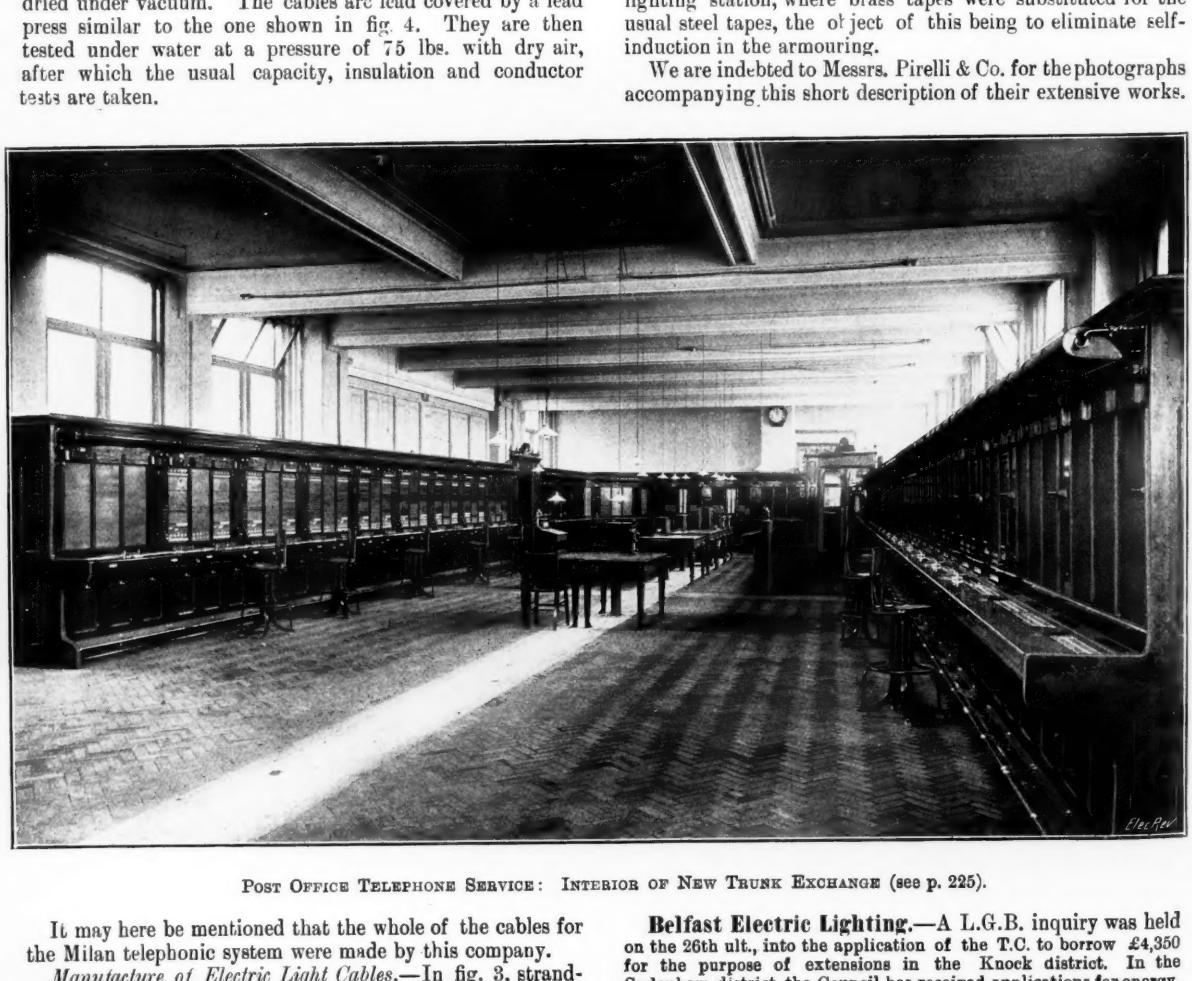
The lead press illustrated is of the Krupp type, the lead being melted in a furnace immediately over the lead press. The lead is run into two cylinders, one on each side of the die block, and is forced out under a pressure of about 2½ tons per square inch. In front of the machine is placed a mirror so as to allow the driver to examine the under side of the cable for pin-holes, cracks, or other flaws.

In fig. 3 the machines for laying up jute worming for filling up the interstices of multi-core cables are to be seen in the foreground; to the right is a steel ribbon armouring machine, and further to the right can be seen a galvanised iron wire armouring machine. These latter machines have discs for laying on the jute serving, taping heads for Hessian tape, and steam-heated compound tanks. After the cables are armoured a further series of tests are taken.

One interesting feature seen was the placing of a layer of paper immediately over the lead and under the jute serving, to act as an additional protection to prevent the corrosion of the lead.

A special cable was made for the Porta Volta electric lighting station, where brass tapes were substituted for the usual steel tapes, the object of this being to eliminate self-induction in the armouring.

We are indebted to Messrs. Pirelli & Co. for the photographs accompanying this short description of their extensive works.



Post Office Telephone Service: Interior of New Trunk Exchange (see p. 225).

Belfast Electric Lighting.—A L.G.B. inquiry was held on the 26th ult., into the application of the T.C. to borrow £4,350 for the purpose of extensions in the Knock district. In the Sydenham district the Council has received applications for energy, and extensions for this were provided and sanctioned in the previous inquiry.

THE NEW TRUNK EXCHANGE OF THE POST OFFICE TELEPHONE SERVICE.

Two years ago we described in these pages the new Central Exchange of the London Post Office Telephones.* This formed part of the local system serving the Metropolitan area, and as we then explained, it provided for intercommunication between this and the other local exchanges of the Government system, which have since then been put in operation, and between the former and the National Telephone Co.'s local exchanges.

We now have to chronicle the completion of the new Trunk Exchange, which provides for telephonic communication between London and provincial and Continental towns. As our readers are well aware, the Post Office authorities have controlled the trunk telephone service since April, 1896, and have very largely extended the network of trunk lines throughout the United Kingdom, besides laying cables to Brussels and Paris; the trunk service has been carried on hitherto by means of a large exchange in the General Post Office, which is now superseded by the new exchange. The change-over took place at the end of last week, and was so organised that no interruption whatever to the service took place, and practically no difference was observable by the subscribers.

The new Trunk Exchange is situated in the same building as the Central Local Exchange, on the floor below the latter; its appearance is shown in the view given on the opposite page. The general arrangement is as follows:—There are positions for 42 trunk operators, of whom 37 will be required in the first instance. Each switch section will be divided into three panels, controlled by two operators; five trunk circuits will be terminated on each of the outer panels, which will also carry the multiples of the junction circuits serving the minor local exchanges. The junction circuits of the principal local exchanges will be multipled on the middle panel of each section, where they will be accessible to either operator. Transfer circuits for interconnecting trunk circuits are provided on each of the trunk panels, as well as foreign, reserve, and the usual official circuits. Apparatus is also provided for terminating a number of local subscribers' circuits which are used only for extensions to the trunk system.

In the centre of the room are the record operators' tables, at which all outward trunk calls from local exchanges are received; the operators at these tables record the particulars of the calls on printed tickets, which are then distributed to the operators at the corresponding trunk sections. When a trunk circuit is at liberty, the London operator proceeds to call the local subscriber who originated the demand, and at the same time calls up the distant Trunk Exchange operator, who obtains the attention of the distant subscriber. At the moment when the two subscribers commence conversation the time is recorded on the record ticket by means of a "calculagraph," which consists of a clock let into the keyboard shelf between two operators at every section, and actuating type wheels, by which the hour, minute and quarter-minute are stamped on the ticket. On the conclusion of conversation, the ticket is again stamped, so that a permanent record of the duration of the conversation is obtained without possibility of error. The tickets, which bear all the necessary data, are afterwards collected and sent to the accounts department to enable the latter to make out the periodical claims for payment.

Inward calls are received by the operators and put through to the local exchanges without passing through the record operators' hands.

The old exchange was a permanent current exchange; the new one, on the other hand, is operated mainly on the central battery system, and consequently all the visual signalling on the switch sections is carried on by means of incandescent lamps, the apparatus on the central record tables alone being of the drop signal type. Many other improvements, which are calculated to add greatly to the efficiency and accuracy of the trunk service, have been adopted in the new exchange.

During the daytime, for example, each operator deals with not more than five trunk circuits; but at slack times, and at night, the latter are concentrated, so that each operator may control 15 trunks. The process of concentration under the old system used to occupy as much as two hours, owing to the necessity of crossing the room to ascertain whether the trunk circuits were disengaged; but under the new *régime* this difficulty will be obviated, as will be shown later.

In a room adjoining the switchroom are situated the intermediate distributing frame, the relay racks, the fuseboard and the testboard. All the trunk circuits pass through the latter, and instruments are provided on an adjoining table, by means of which the several circuits can be tested.

All ordinary subscribers of the Post Office and National services are entitled to the use of the trunk system; the former alone, however, are privileged to through communication with foreign exchanges.

As the trunk service is required to connect together exchanges working on a variety of systems, the arrangements of the apparatus and connections to meet all possible conditions are necessarily somewhat complicated. We propose to give outline diagrams showing the principal connections, with details of the methods of working.

(*To be continued.*)

* Electrical Review, December 6th and 20th, 1901; and January 3rd, 1902.

NOTES.

(*Continued from page* 220.)

A Novel System of Wireless Telegraphy.—Last year some beautiful experiments in wireless telephony were made by Herr E. Ruhmer on the Wannsee Lake, near Berlin, which were continued with increasing success in the course of the summer. Now the inventor has applied his process to optical telegraphy, and the Siemens & Schuckert Works are just now bringing out these novel wireless telegraph apparatus.

In optical telegraphy the rays issuing from a projector are, as a rule, intercepted at given intervals, so as to form luminous flashes, succeeding one another more or less rapidly. In the Ruhmer telegraph system, on the contrary, the so-called *speaking arcs* are utilised by superposing on the continuous current circuit of the lamp placed at the sending station in the focus of a projector, a continuous current rapidly broken by means of a mechanical interrupter, the opening and closing being performed by a Morse key in accordance with ordinary Morse signals. At each closing of the telegraph key, the superposed and frequently interrupted continuous current will modify the luminous intensity emanating from the electric arc, giving rise to luminous oscillations which are projected towards the receiving station. If all the conditions be so arranged that the luminous intensity of the lamp is maintained constant, this process will ensure not only a more rapid handling of telegrams, but will permit, at the same time, of keeping the latter strictly secret, as the human eye, incapable of discerning more than ten luminous alternations per second, will get the impression of a continuous beam, on account of the rapidity with which the luminous oscillations of the transmitting station will succeed each other.

The receiving station is arranged in a way analogous to those of optical telephony, comprising two telephones and one parabolic reflector, in the focus of which the selenium cell is placed. The luminous oscillations of the transmitting station are perceived in the telephone of the receiving station by means of the selenium cell as humming intermittent sounds, constituting *acoustical* and directly perceived Morse signals. The pitch of the sound will depend on the frequency of the interrupter. Whereas in transmittting speech uncertainties are possible on account of the different acoustical intensities of the different vowels, the same sounds are heard here for more or less prolonged intervals. It has, therefore, been possible to ensure perfectly clear transmissions of signals in atmospheric conditions which would have rendered difficult the transmission of speech. The beginning of a communication is indicated by a bell, operated by the selenium cell without the agency of any wire connecting it with the transmitting station.

The satisfactory results of the experiments so far made go to show that this system of optical telegraphy, like the analogous system of optical telephony, will be used to special advantage in the case of transmissions over brief distances. It will, therefore, be especially suitable for military and naval purposes.

Chatham Dockyard.—The Electrical Department at H.M. Dockyard, Chatham, is rapidly extending its operations. The Lords of the Admiralty have recently approved the appointment of three additional chargemen in the electrical engineers' department.

The Decimal System.—We recently received a batch of documents from the secretary of the Association, from which we learn that a petition is now being extensively signed throughout the kingdom in support of the Bill for the adoption of the metric weights and measures which will be introduced in the House of Lords by Lord Belhaven, and will be seconded by Lord Kelvin.

The International Electrical Congress of St. Louis. The International Electrical Congress, to be in session at St. Louis, September 12th—17th, 1904, promises to amass a considerable amount of valuable engineering literature. Up to date about 3,550 circular letters of invitations to join the Congress have been issued in North America, and 875 acceptances of membership have been received. About 5,000 invitation circular letters in American and about 6,000 in foreign countries will be issued. It is expected that many persons will join the Congress, both in America and abroad, who do not expect to attend the sessions in St. Louis, in order to secure a copy of the Transactions, which will form one, and perhaps two, large octavo volumes. Recently 280 special letters of invitation have been issued on behalf of the Committee of Organisation to prominent electricians and electrical engineers, signed by the President and the general secretary of the Committee, requesting papers for the Congress in the various sections. Of these, 146 have been sent to foreign authors, and 134 to American authors. As a result, 67 papers are already promised for the Congress, and the number is steadily increasing. A considerable further number of invitations to contribute papers have yet to be issued. It is hoped that at least half of the papers may be from foreign countries. According to the plans of the Committee, papers for the Congress programme are specially invited, but papers voluntarily offered will be submitted to the officers of the sections to which the papers belong, and may be included in the programme by invitation at their request, if the subjects are desirable, and if the schedule allotted to each section will permit; it being the desire of the section officers to secure and offer the best possible programme. The Department of State at Washington, having been urged that the various foreign governments should be invited to appoint official delegates to the Congress, has instructed the diplomatic officers of the United States abroad to extend an invitation to foreign countries to be represented at the Congress by delegates.

Arrangements are being made with a view to perfecting plans of co-operation between the Congress and electrical societies and associations in various parts of the world. Invitations have already been extended to the Congress members to visit places of electrical interest on the journey to and from St. Louis.

The Committee of Organisation of the Congress consists of Elihu Thomson, president; A. E. Kennelly, general secretary; W. D. Weaver, treasurer; Bion J. Arnold, vice-president and chairman of Executive Committee; C. F. Scott, Dr. S. W. Stratton, Prof. H. S. Carhart, and Prof. W. E. Goldsbrough, vice-presidents.

The following section officers have been appointed by the President, and have already done much work in organising their sections:—

Section A	General Theory,	Prof. E. L. Nichols. Cornell University,	Prof. H. T. Barnes, McGill University.
Section B	General Applications,	C. P. Steinmetz, Schenectady.	Prof. Samuel Sheldon, Brooklyn.
Section C	Electro-chemistry,	Prof. H. S. Carhart, Univ. of Michigan.	Carl Hering, Philadelphia.
Section D	Elec. Power Transmission,	Mr. C. F. Scott, Pittsburg.	Dr. Louis Bell, Boston.
Section E	Electric Light and Distribution,	Mr. J. W. Lieb, jun., New York.	Mr. G. S. Dunn, New York.
Section F	Electric Transportation,	Dr. Louis Duncan, Mass. Inst. of Technology.	Mr. A. H. Armstrong, Schenectady.
Section G	Electric Communication,	Mr. F. W. Jones, New York.	Mr. Bancroft, Gherardi, N.Y.
Section H	Electro-therapeutics,	Dr. W. J. Morton, New York.	Mr. W. J. Jenks, New York.

All communications should be addressed to the general secretary, Dr. A. E. Kennelly, Havard University, Cambridge, Mass, U.S.A.

The Criton Water Softener.—In the Criton water-softener of the Pulsometer Engineering Co., of Reading, there is a simple tank, which is so arranged that as each tankful of hard water is automatically discharged to the mixer it moves a displacer in the soda tank, and causes a given volume of soda water or other requisite solution to be discharged into the mixer. Thus, the reagents are exactly proportioned to the demand. From the mixing tray the water falls down a long pipe to the bottom of a tall tank, in which the salts are deposited. The settled water overflows thence to the filter, which can be cleaned without removal of its filtering medium. There are no small openings to choke with sediment, and the whole plant appears to be designed with a minimum chance of getting out of order. The lime-water tank is tall, and water is fed into its base, so that a well saturated solution of uniform density is secured. The apparatus can be used to soften water with any reagent that may be necessary. As a rule, the simple Clark process, with lime, and, perhaps, a little soda, will best suit nine waters out of ten. A little alum may be added where there is organic impurity present. The Criton apparatus is certainly constructed on sound principles, and is, moreover, simple. For boiler working, we consider the omission of softening is a serious error, especially in the south of England, where all water is hard as a rule, coming as it does from a chalk country.

South African Notes.—The Natal Government Harbour Department are about to call for tenders for a Telpherage plant for handling goods inside warehouses at the Point, Durban. There will be 12 Telphers at first, the power for which will be supplied from the Harbour Board power station."

Tenders are also being called locally for a coaling plant for the above Department, which, we understand, is to be operated electrically.

Municipal Electric Wiring.—It is stated that a number of municipal authorities, especially in London, are working with a view to getting powers granted by Parliament permitting local authorities to wire consumers' premises. We have no doubt that the various Electrical Contractors' Associations are on the alert.

The Yorkshire College Engineering Society, Leeds.—At a recent meeting of this Society, Mr. Frederick Grover gave an account of his experience in India, where he went as Special Commissioner to the Indian Government to investigate the smoke nuisance in Calcutta. The poor quality of coal, combined with the low intelligence of the native stokers, and the manufacturers' aversion, on the score of expense, to adopting mechanical stokers, renders the smoke question difficult to deal with. Mr. Grover advocated the appointment of a Government Inspector, who should be a competent engineer and chemist, in order that his knowledge and experience should be at the service of manufacturers and coal consumers. He was strongly of opinion that this measure would also have to be adopted in England before the smoke nuisance could be efficiently dealt with. In the discussion which followed the lecture, London, Nottingham and Bolton were cited as cases of towns which are now practically smokeless. The chairman, Prof. Goodman, considered that under thoroughly competent supervision, a town like Leeds could be rid of smoke in five years.

Mr. C. G. Petree read a paper on "Rotary Engines," describing and illustrating a rotary engine now on the market, for which the following advantages are claimed:—Small size and weight (about 34 lbs. per B.H.P.); slight vibration, with silent smooth working; very little friction, except that of rolling; enclosed working parts, a great benefit in dusty or gritty surroundings; practically no risk from priming boilers; much lower first cost, and easily interchangeable parts; this engine has been submitted to efficiency and endurance tests, and has given very satisfactory results.

Mr. L. Reynolds also read a paper on "Some Details of a Flour Mill Plant."

Electricity in Mines.—The report of the Departmental Committee on the Use of Electricity in Mines has been issued as a Blue-book. The Committee was appointed in October, 1902, to inquire into the use of electricity in coal and metalliferous mines, and the dangers attending it; and to report what measures should be adopted in the interests of safety by the establishment of special rules or otherwise. Mr. Cunynghame was appointed chairman, and Capt. A. Desborough, H.M. Inspector of Explosives, was made secretary to the Committee. The Committee suggest, as general principles which should govern the employment of electricity in mines, as follows:—(1) The electric plant should always be treated as a source of potential danger; (2) the plant, in the first instance, should be of thoroughly good quality, and so designed as to ensure immunity from danger by shock or fire, and periodical tests should be made to see that this state of efficiency is being maintained; (3) all electrical apparatus should be under the charge of competent persons; (4) all electrical apparatus which may be used when there is a possibility of danger arising from the presence of gas should be so enclosed as to prevent such gas being fired by sparking of the apparatus; when any machine is working, every precaution should be taken to detect the existence of danger, and on the presence of gas being noticed, such machines should be immediately stopped. Passing to the application of electricity, they formulate the general principles which should be followed in reference to generating stations, cables, switches, fuses, &c., stationary motors, portable motors for coal-cutters, drills, &c., electric locomotives, electric lighting, shot-firing, signalling, and electric re-lighting of safety lamps. The Committee state that there may be parts of mines in which so much fire-damp is emitted that the introduction of electricity might be improper, notwithstanding the fact that by law these places may be worked with safety lamps. They wish, therefore, to impress emphatically on both colliery owners and managers that the ultimate responsibility of installing or using electricity in such places should and must rest with them. The Committee have drawn up a set of rules which they think might, with advantage, be introduced into all mines. The rules are appended to the Blue-book, and deal in detail with general regulations.

At a joint meeting of the Midland Counties Institute of Engineers and the Midland Institute of Mining, Civil, and Mechanical Engineers recently held in Sheffield, a description was given by Mr. P. C. Greaves, Denby Grange Colliery, of an electrical heading machine. As electric power was used in the mine for hauling and cutting coal, it was decided to use this power for the header, and a Jeffrey machine was obtained from America, there being no such electrical machines made by British firms. This machine had been at work since April, 1903. It took some 26 amperes at 480 volts at the present rate of cutting. During three months the machine made 226 cuts to an average depth of 5 ft. 7 in., and 415 yards had been driven. After a cut was made, an electric drill was used to make a hole on either side of the heading. It took 5 min. to set the machine and drill a hole 6 ft. long. The machine saved 4s. 9d. per yard, compared with the miners' price, and 3s. 1d. per yard after allowing for all charges.

Other speakers testified to the value of the machine, and Mr. Greaves stated that he had discarded a heading machine driven by air, on account of excessive sparking.

London Gas Supply: Stoves and Slot Meters.—Electric lighting men will be interested to note the figures of the business done last half-year by the Gas Light and Coke Co. The quantity of gas sold during the half-year was 10,242,436,000 cb. ft., which is less by ¾ per cent. than the quantity sold during the corresponding period of 1902. The additions to the number of consumers are considerable, especially to those on the automatic meter system, the company having added during the past half-year 14,911 new supplies, of which 11,900 are on this system. The number of stoves sold and let on hire has increased by 11,779 during the same period.

Calorimeter Comparisons.—In measuring the calorific capacity of fuels we have found different experimenters to give extraordinarily different results. Messrs. Brame and Cowan, in a recent paper to the Society of Chemical Industry, quote some tests made with three calorimeters, which gave results from 6,607 to 7,316 for one coal and 7,260 to 8,445 for a second coal. These were not "Combe" instruments. The authors of the paper made a series of tests with different calorimeters, in which combustion was effected by various methods. We need not detail the preparation of samples to be tested. The Lewis-Thomson calorimeter, they consider only suitable for approximate comparison of coals of a very similar nature, but Scheurer-Kestner added 15 per cent. for losses, and found that it gave results agreeing within a maximum of 4 per cent. The instrument appears to give the best result with the more bituminous fuels. The William Thomson instrument appears to come in for better appreciation. The Fischer calorimeter does not seem to give perfect combustion, and a thin smoke is always produced. Carbon monoxide and hydrogen appear in the waste gases. In the Lewis-Thomson instrument there is always much fuel unburned, and this is estimated by weighing the ash and burning out the coal, but it is properly asked, Has the portion of coal thus burned the same calorific value as the part which was burned in the instrument? In any calorimeter a residue of unburned fuel cannot be accurately allowed for. The William Thomson calorimeter more nearly approached the results of the "Combe" in its mean results, but there was always an error due to escaping smoke. The Fischer instrument gave concordant results for each coal individually, but its mean results compared badly with those of the Combe instrument. The formula used in calculating heat values was—

$$Q = \tfrac{1}{100}\left[8{,}140\,C + 34{,}500\left(H - \frac{(O + N - 1}{8}\right) + 2{,}220\,S \right],$$

and in every case the calculated value was below the determined value, a fact that would seem to point to some inaccuracy of the formula. In the four instruments named the percentage of error on five coals ranged from 6·4 with the Lewis-Thomson instrument on an anthracitic coal down to 0·3 for the Mahler Combe, which gave very uniform errors throughout. The L. Thomson instrument had errors of 6·4 to 2·3, the Wm. Thomson from 4·4 to 1·8, the Fischer from 1·27 to 0·6, and the Mahler from 0·3 to 0·16. The authors attribute the difference between calculation and experiment to the omission of allowance for formation of nitric acid, and for all technical purposes they think that the value of a coal can be calculated from its analysis. The conclusion as to instruments is that the Combe is alone really reliable, but is not a rough-and-ready instrument. The general trend of the paper is to the effect that no reliance can be placed on any determination, and that the fuel calorimeter is little better than the steam calorimeter, of which it was recently said, with two observers, two results were got, and if each observer used two instruments, there would be four results. Fuel calorimetry may, however, start with fairly representative samples of fuel, whereas no one can tell the amount by which a sample of steam departs from the quality of steam in the pipe whence the supposed sample was drawn.

German-Austrian Fusion: Another Electrical Amalgamation.—It is proposed to completely amalgamate the Union Electricity Co. of Berlin with the Allgemeine Electricity Co. of the same city, and the capital of the latter is to be largely increased in order to carry out the absorption. This represents the final stage in the combination of the Edison and Thomson-Houston interests in Germany, the preliminary having been taken by the establishment of a community of interests between the Union Co. and Allgemeine Co. over a year ago. As a result of this fusion, a scheme has been prepared for an amalgamation of the interests held by the two companies in Austria. The Union Co. is represented by the Austrian Union Electricity Co., which has a share capital of £200,000, and has manufacturing works in Vienna, whereas the Allgemeine Co. merely maintains a large sales bureau in the Austrian capital. As the absorption by the Allgemeine Co. of the German Union Co. will be the means of transferring to the former one-half of the capital held by the latter in the Austrian Union Co., it will only be necessary for the German company to acquire the other half, which is mainly in the hands of the Vienna Union Bank, in order to complete the proposed transaction. This will not be a difficult matter, as the Austrian company incurred a heavy loss in 1902, and also, it is believed, in 1903.

The Chicago Theatre Fire.—The Coroner's jury which has been inquiring into the cause of the deaths of the victims of the Iroquois Theatre fire, found that the fire was caused through an electric arc light coming into contact with inflammable stage fittings, and attributed the frightful death roll to gross negligence on the part of the city officials and the managers of the theatre for opening the house before work on all the exits had been completed.

Lectures.—Before the Glasgow University Physical Society last week Prof. Magnus Maclean delivered a lecture on "Atmospheric Electricity."

Mr. J. M. Finnegan, B.A., B.Sc., lectured on "Radium" before the Belfast Natural History and Philosophical Society, on January 28th.

Electric Deck Planer.—The planing of the wooden decks of ships is one of the most laborious and unpleasant operations that falls to the lot of a ship's carpenter, and even the time-and-half rate of wages allowed for this duty does not overcome the dislike for it. It is not surprising, therefore, to learn that the electric deck planer introduced by Messrs. Mavor & Coulson, Ltd., of Glasgow, some years ago has found favour among shipbuilders. A large number of these useful tools have been placed in the shipyards of the Clyde and Tyne, and the repeat orders from German and American users are evidence of the alertness of foreign competitors in availing themselves of labour-saving devices. Until recently these machines were fitted with direct-current motors only, but the introduction to the Tyneside shipyards of three-phase current from supply stations has created a demand for deck planers fitted with alternating-current motors. The illustration shows Messrs. Mavor and Coulson's three-phase deck planer, several of which have been supplied to the Tyne yards. The machine, which is fitted with a

Mavor & Coulson's Electric Deck Planer.

3-h.p. motor running at 3,000 r.p.m., and driving the cutting knives at the same speed, will plane under working conditions on board ship an area of 360 sq. ft. of deck in one hour. The attendance required is one man at 9d. per hour to guide the machine, one apprentice at 1½d. an hour to draw it, and one apprentice at 1½d. per hour to sweep away the shavings, a total of 1s. per hour. By hand labour an area of 45 sq. ft. of deck planed is a fair day's work of a carpenter, for which 10s. is paid. The machine therefore does in one hour at the labour cost of 1s. as much work as eight men do in a day at a cost of £4, and the machine leaves a much better surface. On a vessel of moderate size, the saving effected by the electric machine amounts to about £80.

Personal.—Mr. A. E. Aspinall is leaving the service of the British Westinghouse Electric & Manufacturing Co., Ltd., for that of the De Beers Consolidated Mines, Ltd., Kimberley, and will act in the capacity of manager of the costs department. He leaves for Africa on the 11th inst.

The Birkenhead Corporation Tramways staff on Sunday presented a solid silver table lamp to Mr. A. R. Fearnley, late general manager, on his departure for Sheffield.

We read in a New York exchange that Mr. W. E. L. Gaine and Mr. Frank Gill, of the National Telephone Co., are making a tour of telephone and electrical plants in the States and Canada. Also that Mr. H. F. Parshall is in America for a brief stay. The same contemporary reports that Mr. J. E. Woodbridge, of the railway engineering department of the G.E. Co. at Schenectady, has been transferred to the British Thomson-Houston Co. at Rugby. Mr. Woodbridge is a former editor of the N.Y. *Electrical World*.

We learn that Mr. James Swinburne left London last week for Johannesburg in connection with a power scheme for certain mines.

Mr. Robert Knight, assistant foreman in the Rugby testing and wiring departments of the British Thomson-Houston Co., Ltd., is leaving to take up a position as assistant engineer in the company's Glasgow office under Mr. E. E. Fuller. The Rugby testing department assembled in full force at the Public Hall on January 25th, under the presidency of Mr. George B. Wilson, their chief, to say farewell, and presented him with a leather dressing case and a travelling writing case. The remainder of the evening was given up to music and song.

Out of 100 applicants, Mr. E. Eardley, committee clerk, was on Friday appointed manager of the Stockport Corporation tramways at a salary of £300 per annum.

Mr. G. F. Metzger, A.M.Inst.C.E., M.Inst.E.E., is announcing to his friends that having been appointed consulting engineer to the Manchester Corporation for the completion of the work initiated by him as their city electrical engineer, he will from February 1st, 1904, practise as consultant in electrical and mechanical engineering at 3, York Street, Manchester.

Mr. Patrick G. O'Hara, late of the Brush Electrical Engineering Co., sails by P. and O. steamer from London on the 12th inst. to take up an important appointment on the Kolar goldfields, Mysore State, Southern India.

President Loubet paid a visit to M. and Mme. Curie at their laboratory on Saturday afternoon. M. and Mme. Curie gave an account of their work in connection with radium, and illustrated it with interesting experiments. Before taking his leave M. Loubet warmly congratulated them on the results of their labours.

Appointment Vacant.—Switchboard attendant for Chester.

Rugby Engineering Society.—Before this Society yesterday (Thursday) a paper was read by Messrs. G. A. Neild and P. E. Banting, on "Commutation of Continuous Current Generators and Motors."

Manufacture of Metallic Calcium by Electrolysis.—According to *l'Industrie Electrique*, a new process for the production of metallic calcium, resembling that of aluminium, has been devised by Prof. Borchers and M. Stockem, of Aix-la-Chapelle. While calcium is of no use in the mechanical arts, it will be of great value to the chemical industry, especially in organic chemistry, on account of its powerful reducing action—less than that of sodium or potassium, but greater than that of aluminium, magnesium, or zinc. In the open air it rapidly oxidises, forming quicklime. It is stated that whereas at present the metal costs about 250 fr. per kgm., it can be produced by the new process for only five centimes per kgm.! In the manufacture of iron, calcium will probable be a valuable reagent, replacing aluminium for the purpose of ridding the iron of phosphorus, sulphur, and oxygen. Details of the process of manufacturing calcium are not as yet available.

THE CENTRAL STATION ENGINEER.

The Manchester T.C. has been recommended by the Electricity Committee to make the following increases of salary to officials:—Mr. F. E. Hughes, secretary, from £400 a year to £450; Mr. L. R. Lee, mains engineer, from £300 to £325; Mr. W. E. Foden, accountant, from £250 to £300; Mr. J. A. Cookson, surveyor of mains, from £250 to £275; Mr. J. A. Constantine, steam assistant, from £240 to £255; Mr. E. Bolton, sub-station engineer, from £200 to £225; Mr. F. H. Whysall, resident engineer at Dickinson Street and Bloom Street stations, from £175 to £225; Mr. D. A. Jackson, installation inspector, from £180 to £200; Mr. J. Johnson, accounts and wages clerk, from £180 to £200; Mr. B. Bennison, assistant accountant, from £164 to £180; Mr. S. Charlesworth, chief works clerk, from £160 to £180; Mr. A. N. Moore, shift engineer, from £100 to £180; Mr. H. Lamb, shift engineer, from £150 to £175; Mr. T. Baxendale, shift engineer, from £150 to £175; Mr. E. J. Constable, shift engineer, from £150 to £175; Mr. W. J. Bamber, shift engineer, from £150 to £175; Mr. H. A. Radcliffe, testing assistant, from £150 to £175.

The Tramways Committee of Manchester has recommended the following increases of salary:—Mr. J. T. Oakes, traffic superintendent, from £350 to £400; Mr. Jas. Wood, financial superintendent, from £325 to £375; Mr. A. A. Blackburn, car-sheds superintendent, from £218 8s. to £240 (with house, gas, coal and water); Mr. John Eades, Jun., car works manager, from £220 to £250; Mr. H. Mattinson, assistant permanent way engineer, from £235 to £250; Mr. D. J. Mallahin, permanent way superintendent, from £225 to £250; Mr. Robert Beattle, claims clerk, from £220 to £250; Mr. J. Ashley, clerk of works, from £4 4s. to £4 10s. per week; Mr. G. W. Hancock, chief clerk traffic department, from £163 16s. to £180; Miss M. E. Hunter, ticket superintendent, from £150 to £175. In addition, the following appointments are recommended:—Mr. T. G. King, chief clerk in the permanent way department, at £163 16s., to be superintendent of the stores department, at £200; Mr. F. Broughton, draughtsman, at £163, to be assistant electrical engineer at £200; Mr. H. Jackson, manager's clerk, at £150, to be contracts' clerk at £170.

Mr. F. V. L. Mathias has been appointed borough electrical and tramways engineer at Warrington.

Mr. J. Barnes, of Northallerton, has been appointed switchboard attendant at the Kendal Electricity Works.

At Stretford, on Wednesday last week, Mr. C. A. L. Prusmann, Corporation electrical engineer, Swansea, was married to Miss E. M. Geldart, of Manchester.

The Electricity Committee of Salford T.C. has recommended the following increases of salary to officials in the electric light department:—Mr. Collings, from £150 to £200; Mr. Davidson, from £150 to £175; and Mr. Crossfield, from £150 to £175. The salary of Mr. G. W. Holford, of the tramways department, is also recommended to be increased from £180 to £200.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Cambridge Electric Supply Co., Ltd. (36,457).—A security, dated January 1st, 1904, to secure an unspecified amount, but stamped to cover £20,000, has been registered. Property charged: The company's undertaking and property, including uncalled capital and real, leasehold and personal estates. Holders: E. D. Vaisey, 39, Threadneedle Street, E.C.; and R. J. Moffatt, Sidney Street, Cambridge.

Automatic Electrical Advertising Syndicate, Ltd. (62,115).—This company's annual return was filed on December 22nd, when the entire capital of £4,500 in £1 shares had been taken up. £1 per share has been called up on 3,000, resulting in the receipt of £3,000. 1,500 shares are considered as fully paid. No mortgages or charges.

Sanitas Electrical Co., Ltd. (72,615).—An amended return of this company was filed on November 14th, when 3,750 shares had been taken up out of a nominal capital of £4,000 in £1 shares. £1 per share has been called up on 1,750 shares, resulting in the receipt of £1,750. £2,000 is considered as paid on the remaining shares. No mortgages or charges.

Electric Law Press, Ltd. (72,425).—Issue, on December 28th, of £100 7 per cent. first mortgage debentures, part of series created by resolutions of June 23rd and September 30th, 1903, to secure £500, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. No previous issue of same series.

Cape Electric Tramways, Ltd.—This company's annual return was filed on December 14th, when 480,000 shares had been taken up out of a nominal capital of £500,000 in 500,000 shares of £1 each. £1 per share has been called up on 80,000 shares, resulting in the receipt of £80,000. 400,000 shares are considered as fully paid. No mortgages or charges.

Argentina Electric Traction Co., Ltd. (61,211).—This company's annual return was filed on January 14th. The capital is £500,000 in 100,000 shares of £5 each. All the shares have been taken up, but no calls have been made. No mortgages or charges.

Sherard Cowper-Coles & Co., Ltd. (67,136).—This company's annual return was filed on December 16th, when 6,656 preference and 18,000 ordinary shares had been taken up out of a nominal capital of £25,000 in 7,000 preference and 18,000 ordinary shares of £1 each. £1 per share has been called up on 6,656 preference and 500 ordinary shares, resulting in the receipt of £7,156. 17,500 ordinary shares are considered as fully paid. Mortgages and charges: £6,500.

ELECTRICITY SUPPLY ACCOUNTS.

Hackney Municipal Electrical Supply.

The returns of the first complete year's working of the Hackney electrical undertaking display a marked improvement on anything yet attained in the metropolis, for which they constitute a record. The greater proportion of the steam used is supplied by the destructor plant working in conjunction with the Electricity Works.

It is interesting to note that at the end of September, 1903, some 147 motors of 527 H.P. were connected, and the electrical engineer, Mr. L. L. Robinson, is to be congratulated on these excellent results.

The prices charged are:—Flat rates of 4d. per B.T.U. for private lighting, and 2d. for power.

General Statement for Year ending March 31st, 1903.

Total capital expended	£233,100
Number of units sold—	
Private supply	1,075,962
Public lighting	539,006
Total number of units sold	1,614,968
Equivalent number of 8-C.P. lamps connected	68,897
H.P. of motors connected	381
Number of public lamps	293 arcs
Maximum load in KW.	1,161
Revenue account—	
Gross revenue	£21,368
„ expenditure	£7,835
„ profit	£13,533
Average price obtained—	
Private lighting	3·37d.
Public lighting	2·70d.

	Gross.	Per unit.
Gross revenue	£21,368	3·18d.
Works and distribution costs (including public lighting)	6,231	·93d.
Total works costs	7,835	1·16d.

Profit Statement.

Interest on loans	£9,091
Sinking fund	2,609
Balance transferred to reserve	2,254
By accumulated interest	−421
Gross profit	£13,533

Hackney Destructor Department.

In connection with the above department, some 34,006 tons of refuse were burnt, resulting in 11,578 tons of clinker and ash, and 120 tons of tin cans, &c. The total water evaporated was 41,411,970 lbs., which amount was utilised by the electricity department.

The following is an analysis of the destructor costs:—

		Per ton of refuse.
Oil, waste, water and stores	£61 =	·43d.
Electricity	660 =	4·66d.
Wages of workmen	2,708 =	19·11d.
Repairs and maintenance	48 =	·34d.
Clinker disposal	747 =	5·27d.
Works cost	£4,224 =	29·81d.
Management, &c.	304 =	2·15d.
Total works and management costs	£4,528 =	31·96d.
Financial charges	2,772 =	19·5d.
Total expenses, including all charges	£7,300 =	51·41d.
Income from electricity department	2,280 =	16·0d.
Balance, being cost incurred by Public Health Department	£5,020 =	35·4d.

= 2s. 11½d. per ton of refuse.

St. Pancras Municipal Electricity Supply.

Judging from the excellent credit balance of £16,818 which remains after meeting working and financial charges, the past year has proved a very successful one for the St. Pancras electrical department. The works costs show a drop of ·4d. per unit compared with the previous returns, which embraced 18 months.

The prices charged are:—For private lighting, 6d. and 3d. on the maximum demand system, 5d. per unit flat rate; power, 2d. and 3d. per unit. Mr. Sydney W. Baynes is the borough electrical engineer.

General Statement.

For year ending March 31st—	1903.	15 months, 1902.
Total capital expended	£423,500	£378,086
Number of units sold—		
Private supply	3,310,403	3,588,763
Public lighting	894 647	1,141,077
Total number of units sold	4,205,050	4,729,840
Equivalent No. of 8-c.p. lamps connected	198,463	173,202
No. of motors connected	259	211
Number of public lamps	646 arc	523 arc
Maximum load in kw.	2,741	2,610
Revenue account—		
Gross revenue	£68,372	£74,504
„ expenditure	£36,096	£48,609
„ profit	£32,276	£25,895
Average price obtained per unit—		
Private lighting	4·05d.	3·95d.
Public lighting	3·00d.	3·00d.

For Year Ending March 31st, 1903.

Gross revenue	£68,372	= 3·91d. per unit.
Works and distribution costs (inc. pub. ltg.)	£29,169	= 1·68d. „
Total works costs	£36,096	= 2·07d. „

Profit Statement.

Interest on loans	£9,826
Sinking fund	5,403
Allowance for bad debts	229
Net profit balance carried down	16,818
Gross profit	£32,276

Including amounts brought forward from the previous year, the total balance in hand amounts to £18,153, out of which £7,220 was paid in relief of rates, £8,280 added to the reserve fund, and other amounts written off capital accounts, &c., a sum of £531 being carried forward.

CITY NOTES.

The Marconi International Marine Communication Co.

Major Flood Page presided at the meeting held on Tuesday last at 18, Finch Lane, E.C. In moving the adoption of the report, of which we gave an abstract last week, he said that the chief efforts of the board had been directed towards obtaining a permanent basis for profitable business in the future, and a very considerable further extension of the operations of the company had resulted. When they met last, there were only 25 ships fitted with the Marconi system; there were now 45, and, if they could only continue to get a few more land extensions in some of the Continental countries of Europe, there would be very large extensions to that already very large number. Wireless telegraphy was still apparently to the public something mysterious and intangible, in spite of all that Marconi had done, and in spite of the practicability and utility as evidenced by the large number of connections which were now working regularly and commercially. Therefore, it was very important that when, largely by their own efforts, there was an almost universal popular demand for this new system of communication, they should find themselves in a position to supply the demand upon such terms as would tend to exclude the competition of so-called other inventions. Those of them who had followed what had taken place with wireless telegraphy were aware that there was a conference held in Berlin last August for the purpose of endeavouring to come to some terms, on which wireless telegraphy should be admitted throughout Europe, but mainly put forward, they thought, by the German Government with a view of endeavouring to get the German manufacturers to pursue the business of wireless telegraphy in every possible way on lines in which their companies had been the pioneers. He was not going to enter into a discussion of the technical points, but it was sufficient for him to say that they had established at great expense a world-wide organisation on shore stations for ship telegraphic exchange through agreement with Lloyd's and the Governments of Great Britain, Canada, Italy, Newfoundland, and others, which offered shipping companies taking their apparatus a very large choice of posts with which to communicate. It seemed, therefore, clear that the advantage which they had gained through the merits of the inventions which they had been formed to work and through their commercial enterprise, ought not to be artificially removed by legislation which would put German or other manufacturers, who would be able to get their apparatus adopted by shipping companies, in as favourable a position—apart from technical merits—to send messages as any ships supplied by their own apparatus. The German Government proposed by international legislation practically to place their whole organisation at the disposal of any person who was able to get his apparatus adopted by a shipping company. It was obvious that such an arrangement would entail great commercial injustice upon them and the associated companies, and it would have this further disadvantage—it would render their system liable to disorganisation by the bad working of other systems, in which they would not have the remedy in their own hands. They protested against that, and they had no reason to believe that the English Government would support any such confiscation as that. They protested against any Government being allowed to come and deprive them of the fruits of all the work that the associated companies had been able to do, based on the admittedly well-nigh perfected system of Mr. Marconi. They had got the only two shipping companies worth having in Germany, and when they had stations in Spain and Portugal, doubtless they would get all the vessels which traded to the East and South Africa. Since the report was issued, they learned from the manager of their Canadian company that an Order in Council had been passed, instructing the Minister of Marine of the Canadian Government to contract with them for the establishment of all the stations which the Government proposed to erect on the St. Lawrence—in all, six points, which were to be equipped with the Marconi apparatus.

Mr. H. J. Davis seconded the motion, and the report was adopted.

Waterloo and City Railway Co.

The report for the half-year shows that the gross receipts, less Government duty, amounted to £17,296, and the working expenses to £8,032, being at the rate of 46·44 per cent., as compared with 44·45 per cent. for the corresponding period of 1902. The balance available for dividend, after providing for interest on debenture stock, is £8,455, and a dividend at the rate of 3 per cent. per annum on the ordinary shares will absorb £8,100, leaving £354 to be carried forward. The number of passengers carried during the past six months, exclusive of season ticket holders, was 2,240,864, showing a decrease of 66,277. The season ticket holders on December 31st last numbered 1,434, as against 1,243 at the end of December, 1902.

City and South London Railway Co.

Mr. C. G. Mott presided, as usual, at the half-yearly meeting on Tuesday. In moving the adoption of the report, of which we have already given an abstract, he explained the causes of the decrease in the dividend. The circumstances were exceptional, and the half-year's traffic had to be compared with a half-year when the old L.C.C. horse tramways were in process of conversion to conduit working. A large amount of traffic was consequently temporarily thrown on to this railway, but during the last half they had been subject to competition from these tramways, which were being extensively used. They had also to pay a large sum in connection with the St. Mary Woolnoth Church award, for which additional debenture stock had to be raised, and this meant a larger amount of interest. The outlook was not so hopeless as it looked, for they were getting back steadily the traffic which they lost by the tramway competition. For the first five weeks this year, as compared with the first five weeks of two years ago, they had already shown an increase of nearly £1,000 in the receipts, in spite of the tramway competition. The revenue account showed that, while the decrease in passengers had been 1,166,137, the receipts therefrom had decreased by £10,957, and other decreases brought up the total to £10,995. The season tickets increased in number by 1,952, and in amount by £1,112. The total net decrease was £9,829, and the total amount available for dividend was £28,296, or £8,747 down. After paying preference dividend, they could pay 2 per cent. on the ordinary stock, and carry forward £746. The figures for the comparative half-years were as follows:—

	1903.	1902.
Number of trains run	99,168	102,185
Train mileage..	607,402	625,883
Passengers carried per train	87·84	96·66
Receipts per train	15s. 3d.	16s. 1d.
„ „ train-mile	2s. 4d.	2s. 7d.
„ „ passenger	1·88d.	1·93d.
Ratio of working expenses to receipts	47·86%	44·04%
Expenses per train-mile showed no alteration.		
Locomotive charges..	4·33d.	4·55d.
Traffic expenses	6·9d.	6·3d.

The increase in the percentage on working expenses would, of course, be due to the decreased traffic. Even 47·86 was low, but they hoped to be able to get it very much lower in future. During the half-year they tried a reduction of fares over that portion of the line between the City and Islington; this led to a large increase in passengers, but no increase in receipts, so they were carrying all that extra traffic without any return for it. From this it was clear that the company's future did not lie in the reduction of fares that did not produce a sufficient number of increased travellers to compensate for the reduction. They had not, therefore, attempted any further reductions over the rest of the line. The chairman went on to refer to the reduction in season ticket charges, and to the excellent arrangements which have been made for through bookings over other railways. The board attached great importance to the proposed extension to Euston. The cost of working it would be small, and the capital expenditure was not excessive, and they would get very large traffic from the five railway companies with whom arrangements were being made as to exchange of traffic. The line would be made as soon as they could prudently make it; but it would be some time before they could possibly settle all the plans, and they

hoped that by then the price of the shares would be increased, and enable them to recommend some method of raising the necessary capital without unduly charging the company with serious loss in so doing. The company had lodged an appeal with the House of Lords respecting the St. Mary Woolnoth Church matter.

After a few questions the report was adopted.

Great Northern and City Railway Co.

Sir Charles Scotter presided at the half-yearly meeting held at River Plate House on Tuesday, and there was a large attendance of shareholders in view of the inspection of the line which had been arranged for.

Sir Charles, in moving the adoption of the report, congratulated the shareholders upon the completion of the railway after only four years of constructional work. He proceeded to give his hearers some particulars respecting the line, the districts served, and the special precautions which had been taken to secure the safety of the public. With most of these details our readers are already familiar. In regard to the extension to the Bank, it would be beyond all question to try to raise money at present for this work, but they were hoping that the money market would soon be in such a state that the money could be raised on easy and proper terms. The work would then be taken in hand at once. The advantages of having a 16-ft. tunnel were dwelt upon. The Board of Trade experts had expressed the opinion to the company's engineers that the railway was much in advance of any other tube railway at present constructed. A few minor details in connection with the signalling were being arranged, and Colonel Yorke will make his final inspection on Saturday (to-morrow). The great loss of life on the Metropolitan Railway of Paris was due to the panic which was caused by the tunnels being thrown into darkness. The disaster had an immediate effect upon the receipts of the underground railways in this country. Those of the Central London, and even the Waterloo and City, at once fell off. He proceeded to show that by reason of the lighting arrangements and other precautionary measures adopted, the Great Northern and City Tube was about the safest place that anybody could travel in or even live in. All of these precautions were adopted before the Paris disaster occurred. The French railway authorities, after taking the best advice, were going to adapt their line to the same system of working as had been adopted long ago for the Great Northern and City Co.

The report was adopted.

Central Electric Supply Co.

The directors' report for the year ending December 31st, 1903, which was adopted at the meeting held at Carnaby Street on Monday, reads:—

"Energy has been supplied to the St. James's and Pall Mall Electric Light Co., Ltd., and the Westminster Electric Supply Corporation, Ltd., throughout the year, to an amount of 2,601,087 units. The cost of production has fallen rapidly as the supply has grown. It has already reached a low point, and from the experience gained, the directors are assured that they will henceforth be able to produce on a large scale with very satisfactory results. It has been necessary to charge 3d. a unit during the past year, but it is anticipated that this price will be largely reduced in the early future. Further debenture stock amounting to £38,782 has been issued during the year, and the premium on the issue, after deducting the expenses, has been carried to the credit of capital reserve account.

The net earnings of the company for the year 1903 were ..	£3,902 6 11
Add balance brought forward from 1902	500 13 0
	£4,402 19 11

Which amount the directors propose to carry forward."

Metropolitan Railway Co.

At the half-yearly meeting held last Friday, Mr. J. J. Mellor showed that by various improvements which had been introduced during the last few years, they had regained the greater part of the traffic which had been lost as a result of the Central London tube opening in 1900. In 1903 their traffic was 94 millions, as against 96 millions in 1899. The working expenses were only 50·31 per cent. of the gross receipts last half-year, as compared with 51·93 in the last half of 1902. In regard to electrification, the power-house at Neasden was practically completed and was ready for receiving the main generating machinery. On the 8th ult. he visited the Westinghouse Works, accompanied by the general manager and the electrical engineer, and they had every reason to be satisfied with the quality of the work, so far as they could judge of it in its incomplete state. Mr. Parker had reported to him that the main high-tension cables were being delivered to time, and about 12 miles had been laid. This work was progressing at a rapid rate. The conductor rails were being placed in position, and about 22 miles of this work had been completed. The question of obtaining the sites necessary for the sub-stations on the Circle had proved a difficulty, but this had at last been surmounted and the buildings were in progress. The first portion of the rolling stock was being delivered at the works at Neasden preparatory to receiving the electrical equipment which would be erected on them by the Westinghouse Co. The directors expected that some portion of the Metropolitan system would be running electrically by midsummer, but they were largely dependent on the preparedness of the District Co.—so far, at least, as a portion of their system was concerned. They and the District Co. were acting together—at any rate, so far as regarded this work—through the medium of the joint consultative committee. Difficulties in so large and complicated an undertaking might possibly present themselves, but they hoped, by mutual and conciliatory action, to move forward without friction to the speedy and successful completion of an undertaking which was so essential to the interests of both companies. The directors had already appointed the officers for running the generating station and superintending the electric working generally, and by the aid of this staff a good deal of their own work of installation was being carried out. When the system was "electrified," the service accelerated, and travelling on the Circle made as pleasant as it was now unpleasant, it was not unreasonable to anticipate that the traffic on that portion of their system might be increased by 50 per cent.

A special meeting followed, at which a resolution was passed approving the scheme for consolidating the existing capital and securing powers for raising an additional £750,000.

Central London Railway Co.

The report for the half-year ended December last, states that the amount expended on capital account during the half-year was £44,226. Receipts from all sources of revenue amount to £175,235 and working expenses to £97,363, leaving a balance of £77,871 carried to the net revenue account. The number of passengers carried was 21,774,850, a decrease of 650,926. In the half-year ended December 31st, 1902, the ordinary daily traffic was exceptionally increased by the attraction of His Majesty's Coronation and its attendant festivities. The workmen carried in the half-year were 3,012,210, being about 14 per cent. of the total number of passengers conveyed. After providing for interest on the debenture stock the net revenue account shows an available balance of £116,504, including £10,426 reserved to meet the dividend on the deferred stock, and £45,406 brought forward from last half-year. The directors recommend the declaration of the following dividends for the half-year:—On the undivided ordinary stock at the rate of 4 per cent. per annum, on the preferred ordinary stock at the rate of 4 per cent. per annum and on the deferred ordinary stock 4 per cent. per annum for the whole year. Reviewing the working of the company's undertaking for the year 1903, the following *résumé* gives the financial result:—Brought forward from the half-year ending December, 1902, £27,717; total net revenue, half-year, June, 1903, £120,617; deduct debenture interest and dividend, &c., £64,785; and reserved for dividend on deferred stock, £10,426, leaving balance carried forward June 30th, 1903, £45,406. Total net revenue, half-year, December, 1903, £134,735. Deduct debenture interest and dividend (including £10,426 reserved from June half year), &c., £88,656, leaving balance unappropriated at December 31st, 1903, £46,078. The board recommends that £10,000 be added to the reserve fund, increasing the latter to £30,800, and that the balance of £36,078 be carried forward. The additional sub-station at Bond Street is practically complete, and will be brought into service shortly. The large fan at Shepherd's Bush is now in regular working order, with the result that the air in the tunnels has been considerably improved. The new motor-cars are also found to work satisfactorily. The company have arrived at a final settlement with the Electric Traction Co., all points of difference having been submitted to and decided by the arbitrator, Sir Benjamin Baker.

Sir Henry Oakley presided at the half-yearly meeting, held at Holborn Restaurant on February 3rd. During the six months they had issued £150,000 stock at par, which had been added to their resources, and they had spent £44,000 upon completion of works, and had £60,000 unexpended. There was no serious additional expenditure contemplated; they might spend £160,000 in the future, but that was an estimate only, and they had powers for £350,000 still authorised. At first blush the revenue statement for the half-year did not look very bright. There was a diminution of 650,000 in passengers and a decrease of £6,645 in balance to net revenue; but when the accounts were analysed, they found that the last half of 1902 had an extraordinary increase owing to the Coronation. There was no remarkable diminution at any points, the reduction of passengers being spread over all the stations. There had been practically no competition which had touched them, and there was nothing which presented any discouraging features at all. The expenses were practically the same, and the average receipt per passenger remained the same, viz., 1·86d. They had increased the service in the busy hours of the morning with a view to avoiding the complaints of overcrowding, and the complaints had ceased to be made. Sir Henry then summarised the financial result, as shown in the above report. He had been asked why they kept so large a sum in hand, but they were aware that the Royal Commission on London Traffic was still sitting, and until that Commission had reported, and they knew reasonably well what views were taken by the authorities with regard to the provision of such traffic, they thought it well to leave the amount in abeyance. In two years they had practically realised £66,000 beyond the amount divided, and that amount was in their books, and had not been spent or pledged, excepting a sum for Parliamentary expenses. The adoption of the Thomson-Houston multiple unit system had enabled them to overcome the vibration troubles, and they were satisfied with the change. The Paris railway authorities, who had been so unfortunate had, after inquiry, adopted the same principle. The sub-station at Bond Street was nearly

completed; it was for the purpose of separating the lift from the power circuit, so that if any accident or stoppage of the power occurred, there would still be the means of lighting the tunnels from end to end, and taking passengers up and down the lifts. The large fan at Shepherd's Bush had effected a great improvement in the ventilation, but it was fair to say that they did not think it was perfect yet. The matter continued to occupy attention, and would be still further improved.

Lord Knollys seconded the adoption of the report, which was carried. Resolutions declaring dividends, re-electing directors and auditors were passed, and a vote of thanks closed the meeting.

St. James's and Pall Mall Electric Light Co.

The directors' report for the year ending December 31st, 1903, to be submitted to the meeting on February 9th, reads:—

The supply has been distributed from the Carnaby Street and Mason's Yard stations of this company to a total of 254,468 8-c.p. lamps, being an increase of 21,783 in the past 12 months. For this purpose 6,662,228 units were generated at these stations and 1,118,082 units were purchased from the Central Electric Supply Co., Ltd. An agreed price, high enough to cover the abnormal cost of production during the initial stages of working, has been paid to the Central Co. for current supplied. To meet this extra charge on the year's working, a sum of £2,500 has been transferred to net revenue account from the contingency fund specially provided last year for this purpose. For the information of the shareholders, a copy of the report and accounts for the past year of the Central Electric Supply Co., Ltd., is enclosed.

The net profits applicable to dividend on shares for the year 1903 were	£35,952 5 3
Add balance brought forward from 1902	2,792 11 8
	£38,744 16 11
Less interim dividend, paid in August last, for half-year ending June 30th, at rate of 7 per cent. on preference shares, £3,500; 10 per cent. on ordinary shares, £10,000 ..	13,500 0 0
Leaving an amount now to be dealt with of	£25,244 16 11

The directors propose to divide this amount as follows:—

(a) By payment of a dividend at the rate of 7 per cent. on the preference shares for the second half-year..	£3,500 0 0
(b) By payment of a dividend on the ordinary shares for the second-half-year of 7s. 6d. per share, and a bonus of 2s. per share, making, with the interim dividend paid on August 1st last, a total distribution of 14½ per cent. for the year	19,000 0 0
(c) Amount to be carried forward	2,744 16 11
	£25,244 16 11

Statement of Electricity Generated, Sold, &c., Year ending December 31st, 1903.

Board of Trade units.	Quantity utilised.				Quantity expended in distribution.	No. of lamps on circuit Dec. 31, 1903.
	Private supply.	Public lighting.	Used on works.	Total.		
Generated, 6,662,228 / Purchased, 1,118,082	6,871,881	145,848	122,476	7,140,205	640,105	254,468

Charing Cross and Strand Electricity Supply Corporation, Ltd.

The annual meeting was held at 60, St. Martin's Lane, W.C., on Wednesday last. Mr. W. F. Fladgate, who moved the adoption of the report, which was given in our last issue, said that they might congratulate themselves on the progress made during the past year. It had been most satisfactory. In the two districts, the West End and the City, they had added no less than 146,700 8-c.p. lamps. Although that was 13,000 less than the figure for 1902, he believed that per area no other metropolitan company had had so large an increase in any one year. They had now a total of 578,044 lamps connected with their works. He might point out that such an increase could not have been made without an expenditure of a large amount of capital in the City and West End. The demands of their engineer had seemed at times to be somewhat rapacious, but however rapacious they had seemed to be, they had been amply justified in every instance where they had been followed. Taking the City undertaking, he said that there was still £200,000 which remained unproductive, which was represented by the crop which they hoped to reap in the general profit from lighting the City. Twenty per cent. of the capital expended in the City remained unproductive. However, they had a generating station at Lambeth, and one at Maiden Lane, and one at St. Martin's Lane. There was a great capacity for further development by the amplification of machinery and plant. One instance in which they had incurred great capital expenditure, without at present having a corresponding increase of revenue, was the case of the trunk main from their power station at Bow to the West End area. That trunk main was a most important factor in their undertaking, for without it they would not be able to carry on their business, yet it was at present used up to only half its capacity. With regard to progress in the West End, he gave the following particulars:—The number of lamps had been increased by 55,326, which exceeded by nearly 21,000 lamps the number added in the previous year, and brought the total up to 335,031 lamps. Speaking of the various districts of the West End, he said that Holborn and St. Giles was a poor district, and there the increase had not been so large as in some of the others. There was also a large amount of demolition going on, but within the next two or three years, when the rebuilding was gradually completed, the increase from that area should be exceedingly satisfactory. The revenue from sales of current for the year was £110,083, an item which showed an apparent shrinkage from the previous year, when the amount was £114,358, but the shrinkage was due to the supply which the West End had been obliged to make to the City undertaking. The previous year the amount was £8,000 for the supply of energy to the City, and this year the purchase of current in bulk by the City amounted to only £1,063. Although their progress had been good, still they were not satisfied with the result. They hoped that they would have had a larger increase of revenue, and doubtless the main cause for the increase not being so large was the singular absence of fogs during 1903. There had been a great amount of rain, and the rain had apparently washed the air clear. However, their affairs were receiving the careful consideration of the directors, and he had every hope that during the current year things would be more satisfactory. The item of coal was again satisfactory. The proportion consumed per unit of energy had gone down. The company, he believed, now held one of the best places with regard to the proportion of coal burnt per unit. The amount for coal in the accounts stood at £16,823 for the West-end undertaking, and £11,696 for the City. The City sold a large amount of energy in bulk to the West-end. With regard to rates and taxes, they had gone up; they always did do so. For depreciation they had allowed £10,000, which they considered was sufficient for the current year. The balance carried to net revenue was £39,111, which they were bringing forward, as in the year 1902. The balance-sheet showed that they had £200,000 in ordinary shares of the Charing Cross and City Electric Co., from which they anticipated a large amount of revenue in the future, perhaps in the year 1905. The £160,500 5 per cent. debentures was simply a temporary matter, merely the cross account of the two companies. The net revenue would pay a dividend of 12 per cent. for the half-year, which would be at the rate of 10 per cent. for the year, and would leave £3,140 to be carried forward to revenue account. If the directors had recommended a smaller dividend, the shareholders could not have altered it, but it was competent for the shareholders to take less than that recommended. The question had received the gravest attention of the board and its advisers. They had earned a sum sufficient to pay a 10 per cent. dividend, but they had been considering whether it would not be better to hold a certain amount in hand. The £3,000 was not a large amount to carry over. They could not prophesy for the future, but there might be contingencies and accidents to provide for. He, therefore, would move an amendment for the reduction of the dividend by 2 per cent. He thought that they would be well advised not to eat all their cake that day, but to save some for the present year. The result would be that the £3,140 to be carried over would be increased to £10,140. With regard to the City undertaking, he had suggested last year that the sales for 1903 would reach £60,000. They had not reached quite that, but they had amounted to £56,000. Looking at the fact that the gross revenue for 1902 was £27,714, he thought that it was none other than a bold view that they should double it. If they had had darker days they would have done it, and, perhaps, no reduction of dividend would have to be made. The total number of lamps now connected was 242,113, the increase for the past year having been 91,884 lamps. They had paid the whole of the interest on the borrowed money. Coal costs were satisfactory. The distributing station in Beech Street had been completed, and the machinery was being installed. The main to the City was most important, as without it, it would have been impossible to carry out the supply to the theatres; which now were required to have two sources of supply. Their stations at Bow and Lambeth could now supply those demands. In conclusion, he said that he was hopeful that in the future the West-end would be even more successful than in the past. There was ample room for two companies in the City, as was proved by their having nearly a quarter of million of lamps, although they had been supplying but a short time. It was not necessary at present for the City to set apart anything for depreciation. He paid a tribute to the other directors, and to the engineer, Mr. Patchell.

The motion was seconded by Mr. G. H. Brougham Glasier.

Mr. Alexander Laurie said that, while disappointed at going away a poorer man than he expected he would be, he had pleasure in supporting the motion. Would the amount over be carried forward to the general revenue account?

The Chairman replied that it would, and the report and balance-sheet were then adopted.

A dividend of 4½ per cent. on the preference shares, and of 10 per cent. on the ordinary shares was agreed to, and the retiring directors were re-elected; 1,500 guineas were awarded the directors for the past year.

The auditors were re-elected.

A Shareholder wished to know why so large an amount as 26·2 per cent. of the output, and 26·94 in the case of the City should appear as "used on works." It gave him no idea as to what was lost in distribution.

The Chairman said that the matter should receive attention of the engineers.

At the conclusion of the meeting an extraordinary general meeting was held, at which the following resolution was passed:—

That the capital of the company be increased by £500,000 by the creation of 100,000 shares of £5 each, of which 50,000 shall be issued as ordinary shares and 50,000 as preference shares.

Great Northern Piccadilly and Brompton Railway Co.

The report for the half-year ended December 31st last, submitted at the meeting held yesterday, states that the capital expenditure during the half-year amounted to £1,175,504. The estimate for the current half-year is £900,000. The progress of the works during the past half-year has been satisfactory. The Bill promoted by the company in the last session of Parliament received the Royal Assent on August 11th, 1903. Under this Act further capital powers to the extent of £250,000 in shares, with £83,000

borrowing powers, are authorised. The rent due from the Underground Electric Railways Company of London, Ltd., under the terms of the agreement for lease, dated January 13th, 1903, up to December 31st, 1903, permits of a dividend at the rate of 4 per cent. per annum. The dividend declared at the last half-yearly meeting covered the period ended August 1st, 1903. The proposed dividend will, therefore, be for the balance of the year (five months) to December 31st last.

Smithfield Markets Electric Supply Co.

The directors' report for the year 1903, says that the gross profits amount to £6,691, an increase of £625, while the gross receipts have increased by £750. After providing for interest and other charges amounting to £2,530, placing a further sum of £2,000 to reserve fund and £1,500 to depreciation account, there remains a balance of £3,663, including £1,351 brought into the accounts from last year. The directors propose to pay a dividend at the rate of 4 per cent. for the year, £2,400; and to carry forward £1,263. The report says:—

It was considered expedient to adopt a uniform price for the current supplied o the shops in the Markets, and this was done in the spring of 1903. This reduction to the consumers has proved advantageous to the company, the receipts from the sale of current having substantially increased, notwithstanding the lower average price obtained. It is also satisfactory to note that the cost of production has been again reduced. The new generating set referred to in the last report was installed in October last, and is working satisfactorily. The entire cost of this engine and dynamo has been met without raising further capital. Capital account has been credited with the cost of the set replaced. The plant and machinery throughout are in good condition, having been fully maintained out of revenue.

Year.	No. of consumers.	Lamps.	Total revenue.	Gross profit.
1902	371	27,694	£20,565	£6,067
1903	389	31,177	21,205	6,691

Anglo-American Telegraph Co.—The board has resolved, after placing £12,000 to credit of the renewal fund for the half-year, to recommend the declaration of the following dividends:—A balance dividend of 16s. per cent. upon the ordinary consolidated stock; a balance dividend of £1 10s. per cent. upon the preferred stock; and a first and final dividend of 2s. per cent. upon the deferred stock, for the year ending December 31st, 1903. There remains a balance of about £1,128 to be carried forward. These dividends, together with those already paid, will amount to £3 1s. per cent. on the ordinary, £6 per cent. on the preferred, and 2s. per cent. on the deferred stock.

Stock Exchange Notices.—The Committee has been asked to allow the following securities to be quoted in the Official List:—British Columbia Electric Railway Co., Ltd.—Further issue of £40,000 Vancouver Power debentures of £100 each. Commercial Cable Co.—Further issue of £21,979 sterling 500-year 4 per cent. debenture stock, redeemable. The Committee has ordered the undermentioned to be quoted in the Official List:—London United Tramways (1901), Ltd.—Further issue of 17,500 5 per cent. cumulative preference shares of £10 each, fully paid, Nos. 82,501 to 100,000.

Prospectus.—The *Liverpool Overhead Railway Co.* has this week been inviting applications for 6,000 perpetual preference shares (5 per cent.) of £10 each at £9 15s. The list was to close yesterday. The money is needed for constructing the line connecting the railway with that of the L. and Y. Railway at Seaforth, and for other purposes.

Waterloo and City Railway Co.—The directors recommend a dividend on the ordinary stock at the rate of 3 per cent. per annum for the half-year ended December 31st last, carrying forward £355. The dividend at December, 1902, was 3¼ per cent. per annum.

W. T. Henley's Telegraph Works Co.—The Right Hon. Sir Alfred C. Lyall, G.C.I.E., K.C.B., K.C.S.I., has accepted a seat on the board.

Chelsea Electricity Supply Co.—The directors recommend a dividend on the ordinary shares at the rate of 7 per cent. per annum for the half-year to December 31st, 1903, making a total dividend of 5½ per cent. for the year 1903, carrying forward about £1,100.

Newcastle District Electric Lighting Co.—The directors' report shows that there has been a large increase in the electrical energy supplied during the past year. The gross earnings for 1903 were £16,330. The directors recommend the usual dividend of 5 per cent. for the half-year, making the interim dividend 8½ per cent. for the year, leaving £633 to be carried forward.

STOCKS AND SHARES.

Wednesday Evening.

To some extent the opening of a Session in Parliament does influence Stock Exchange business beneficially as a general rule. Whether it will do so this month is more doubtful than usual, but dull as these times are, the investment departments score considerably over the speculative, for whereas the latter hang limp with inanition, the investor does make his presence felt in a slight degree amongst the former. The Electricity Supply list, for example, shows several advances, and the deduction of dividends in other directions has left the majority of prices unchanged, this being the case especially in regard to telegraph issues.

While the Home Railway distributions have made a better showing on the whole than had been anticipated, the Waterloo and City announcement is disappointing. The two previous dividends at the rate of 3¼ per cent. per annum had occasioned reasonable hopes that such was to be the general rate in future, and the loss of the fraction has come as a surprise. The price of the stock is left unaltered at 92½, but it is a good deal more nominal than actual. City and South London is a point harder upon the chairman's speech at the meeting last Tuesday, which was expected to be guardedly optimistic, as it turned out to be. The Central London trio has not changed. Metropolitan steadied to 88 at the prospect of an early completion of the electrification, and Districts at 35 are unaltered upon a continuance of the former 1½ per per cent. dividend for the 4 per cent. Guaranteed Stock. The Great Northern, Piccadilly and Brompton report speaks of three years as the likely limit of time required to finish the railway, and in the meantime the price of the shares is 9½. East Londons mark 4⅞ this week, and Great Northern and City Preferred are 7½.

Electricity Supply shares, as noted above, are harder in price, and the dividends have produced a quiet demand for the better class descriptions. Forecasts of better dividends that were ventured upon in these columns a few weeks back have been confirmed in the cases of the Brompton, Chelsea, Smithfield and Westminster Cos. Rises of ¼ are credited to the Ordinary shares of the first two. St. James's are 10s. better at 13½, while Metropolitans have gained £1 at 18½. Urban Ordinary show a loss of 2s. 6d., but South Londons continue their rising tendency, and are another 5s. up, at 4. The Metropolitan advance is due to the prospects of a termination to the Marylebone deadlock. Our canny contemporary, *Electrical Investments*, remarks that "the Mayor stated Council's opinion has been taken," but omits to say what "Council."

Edmundson's have not yet recovered their slight relapse upon the new issue of shares, to which reference has already been made. We gather, unofficially, that the appeal was very successful, and that several of the underwriters, who wanted the shares for investment, had to be disappointed, because the Edmundson shareholders relieved them of the responsibility of taking any of the new shares. Charing Cross are a ¼ down upon the very unusual step taken at the meeting this (Wednesday) afternoon in resolving to pay a less dividend than was recommended in the report. Prudence will, of course, approve this step. Not very successful was the appeal of the British Electric Traction Co. for its £250,000 in Second Debentures. The amount having been underwritten by the Electric and General Investment Co., the result makes little difference to the Traction undertaking, but it is said that the public response to the issue was well under 50 per cent. of the total sum offered. The stock is well-enough secured to make it worth acquisition if the price should decline to a reasonable discount—say if it goes between 90 and 95 for the fully-paid scrip. There is a talk of agreement among the large holders not to sell below par. The Ordinary shares are down ¼, to 11¼. Anglo-Argentine Trams at 5, Buenos Ayres and Belgrano Ordinary at 3½, and Calcutta Trams at 6⅞ have scarcely varied on the week. London United Debenture at 104 is a shade lower. North Metropolitan Tramway shares, carrying their dividend at the rate of 4 per cent., keep at 2⅞, and the 3½ per cent. debentures about 90, the threatened deadlock as to the system of traction to be adopted by the London County Council in the north of London being regarded with indifference by the market.

Most of the alterations in the Telegraph list have *ex* dividend markings as their cause. To mention some of those which have not been changed in price, there are Direct U.S. Cable, *ex* 3s., both the Globe Telegraph and Trust shares, *ex* 2s. and 3s. for the Ordinary and Preference respectively, and West African Telegraphs, where the deduction is a florin per share. Great Northern Telegraphs are still a weak market, displaying a further drop of 10s., which leaves them at 24. In the Anglo-American group, the declaration of 2s. per cent. dividend on the "A" stock met general expectation, and none of the issues have moved. Submarine Cables Trust are a point lower.

National Telephone varieties keep firm, the only change being shown by the First Preference shares, which are ½ up at 14½ on the scarcity of supply. Chili Telephones at 5 are *ex* 3s. dividend. Henley's fell sharply to 11½, and the new Ordinary to ¼ premium, but now that the day for applying for these latter has passed, there should be a recovery. The new Preference shares command no premium at present.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1901.	1902.	1903.	Closing Quotations Jan. 27th.	Closing Quotations Feb. 3rd.	Business done week ended Feb. 3rd, 1904. Highest	Lowest
67,100	African Direct Telegraph, 4 % Debs.	100	..	..	..	98 —102	98 —103	..	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	..	..	..	2½ — 3½	2½ — 3½	..	..
119,700£	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	..	..	..	.. — ..	70 — 80	..	..
788,840	Anglo-American Telegraph	Stock	61s.	60/6	61s.	50 — 53	50 — 53	51½	..
8,105,580	Do. do. do. 6 % Pref.	Stock	6 %	6 %	6 %	96 — 97	95 — 97	96½	95½
8,105,580	Do. do. do. Deferred	Stock	2s.	1/-	2s.	7⅞ — 8¼	7⅞ — 8¼	7¹⁵/₁₆	7⅞
44,000	Chili Telephone, Nos. 1 to 44,000	5	5 %	6 %	..	4¾ — 5¼	4¾ — 5¼ xd	..	..
18,333,300$	Commercial Cable	$100	8 %	8 %	..	180 —190	180 —190	..	..
1,841,209	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	..	..	..	88 — 92	89 — 91	91⅜	90
16,000	Cuba Telegraph	10	4 %	6⅓%	..	7 — 8	7 — 8	..	..
6,000	Do. 10 % Pref.	10	..	..	..	16 — 17	16 — 17	..	..
12,931	Direct Spanish Telegraph	5	4 %	4 %	..	2½ — 3½	2½ — 3½	..	..
6,000	Do. do. 10 % Cum. Pref.	5	..	..	..	7½ — 8½	7½ — 8½	8	..
90,000	Do. do. 4½ % Debs.	50	..	..	..	98 —101 %	98 —101%	..	..
60,710£	Direct United States Cable	20	5½%	5½%	..	10 — 10½	10 — 10½ xd	10⅜	..
85,800	Direct West India Cable, 4½% Reg. Deb., within Nos. 1 to 1,200, Red.	100	..	..	..	98 —101	98 —101	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	..	119 —124	119 —124	121	119½
1,955,565	Do. 8½ % Pref. Stock	100	..	..	..	88 — 91	88 — 91	88½	..
1,584,645	Do. 4 % Mort. Deb. Stock Red.	Stock	..	..	..	105 —108	105 —108	107	105½
800,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	..	10¾ — 11¼	10¾ — 11¼	11	10¾
320,000£	Do. 4 % Deb. Stock	Stock	..	..	..	106 —109	104 —107 xd	104¾	..
800,000	Eastern & South African Tele., 4% Mt. Db., Nos. 1 to 8,000, red. 1909	100	..	..	..	99 —102	99 —102	101½	101½
200,000£	Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 8,000	25	..	..	..	99 —102	99 —102	..	..
180,227	Globe Telegraph and Trust	10	5½%	..	..	8¼ — 8¾	8¼ — 8¾	8⅝	8¼
180,042	Do. do. 6 % Pref.	10	..	..	..	12¼ — 13	12¼ — 13	12¹⁵/₁₆	12½
150,000	Great Northern Telegraph, of Copenhagen	10	15 %	12½%	..	24 — 25	23½ — 24½	..	..
58,700	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	..	..	..	98 —101	98 —101	..	..
17,000	Indo-European Telegraph	25	10 %	10%	..	38 — 41	38 — 41	..	..
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	..	..	..	100 —103	100 —103	..	..
1,983,333	National Telephone, Pref. Stock	100	5 %	6 %	..	102 —104	102 —104	103⅜	102⅜
1,966,667	Do. do. Def. Stock	100	..	4½%	..	78 — 81	78 — 81	79¼	78⅜
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	..	13½ — 14½	13½ — 14½	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	..	13½ — 14½	14 — 15	..	..
2,250,000	Do. do. 5 % Non-cum. 3rd. Pref., 1 to 250,000	5	5 %	5 %	..	5⅜ — 5⅝	5⅜ — 5⅝	5⅛	..
000,000£	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	..	96 — 97	96 — 97	..	..
600,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	..	100 —102	100 —102	10 ½	..
179,313	Oriental Telephone and Elec. Nos. 1 to 171,504, fully paid	1	6 %	6 %	..	⅞ — 1	⅞ — 1	..	..
50,000	Do. do. do. 6 % Cum. Pref.	1	..	..	..	1 — 1⅛	1 — 1⅛	..	..
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	10	..	..	..	97 —100	97 —100	..	..
11,839	Reuter's	8	5 %	..	..	6⅞ — 7⅛	6⅞ — 7⅛	..	..
8,308	Submarine Cables Trust	Cert.	..	..	..	118 —123	118 —123	..	..
58,000	United River Plate Telephone	5	7 %	7 %	..	5⅛ — 6	5⅛ — 6	..	..
40,000	Do. do. 5 % Cum. Pref., Nos. 1 to 40,000	5	..	..	..	4½ — 5½	4½ — 5½	..	..
179,947£	Do. do. 5 % Debs.	Stock	..	..	..	102 —105	102 —105	..	..
15,609	West African Telegraph, Shares	10	..	2 %	..	5 — 6	5 — 6 xd	..	..
150,000£	West Coast of America, 4% Debs., 1 to 1,500 guar. by Bras. Sub. Tel.	100	..	..	..	95 — 98	95 — 98	..	..
267,330	Western Telegraph, Ltd., Nos. 1 to 207,930	10	7 %	7 %	..	11½ — 12½	11½ — 12½	12	11⅝
75,000£	Do. do. 5 % Debs. 2nd series, 1906	100	..	..	..	99 —102	99 —102	..	..
400,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	98 —101	98 —101	..	..
88,321	West India and Panama Telegraph	10	..	..	..	⅜ — ½	⅜ — ½	..	..
84,568	Do. do. do. 6 % Cum. 1st Pref.	10	..	..	..	6 — 6½	6 — 6½	..	..
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	..	..	..	4½ — 5½	4½ — 5½	..	..
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	..	..	..	99 —102	99 —102	..	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

20,000	British Aluminium 7 % Cum. Pref.	10	..	..	..	4½ — 5½	4½ — 5½	..	..
300,000£	Do. do. 5% 1st Mort. Deb. Stock Red.	Stock	..	..	..	87 — 91	87 — 91	..	..
100,000	British Electric Traction	10	9 %	8 %	..	11½ — 11⅝	11 — 11⅛	11⅛	11⅛
100,000	Do. do. 6 % Cum. Pref.	10	..	..	..	11½ — 11⅝	11½ — 11⅝	11⅝	11⅛
600,000£	Do. do. 5 % Perpetual Debenture Stock	Stock	..	..	..	120 —123	120 —123	..	..
100,000	British Insulated and Helsby Cables	5	10 %	10 %	..	6 — 6½	6 — 6½	..	..
100,000	Do. do. 6 % Cum. Pref.	5	..	..	..	5½ — 5⅝	5½ — 5⅝	..	..
60,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	..	..	..	102 —107	102 —107	..	..
50,000	¶Browett, Lindley & Co., Ord.	£1	Nil	..	..	⅝ — ¾	⅝ — ¾	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	6 %	Nil	..	14/6 to 15/6	14/6 to 15/6	..	..
105,781	Brush Electrical Engineering, Ord., 1 to 105,781	2	Nil	Nil	..	½ — 1½	½ — 1½	..	..
150,000	Do. do. Non-cum. 6 % Pref.	2	3 %	6 %	..	1½ — 1⅝	1½ — 1⅝	..	..
125,000£	Do. do. 4½ % Perp. Deb. Stock	Stock	..	..	..	97 —100	97 —100	..	..
125,000£	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock	..	..	..	75 — 80	75 — 80	..	..
35,000	Callender's Cable Construction shares	5	20 %	15 %	..	10½ — 11½	10½ — 11½	..	..
40,000	Do. do. do. 5 % Cum. Pref.	5	..	..	..	5½ — 5⅝	5½ — 5⅝	..	..
90,000£	Do. do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	..	..	..	104 —108	104 —108	..	..
1,860,014	Central London Railway, Ord. Stock	Stock	4 %	4 %	4 %	94 — 97	94 — 97	97	..
494,098	Do. do. 4 % Pref. Stock	Stock	4 %	4 %	4 %	98 —101	98 —101	101½	98
494,998	Do. do. Def. do.	Stock	4 %	4 %	4 %	91 — 94	91 — 94	94	..
1,330,000	City and South London Railway	Stock	2 %	3½%	2⅝%	49 — 52	50 — 53	51½	49½
85,000	Crompton & Co., Nos. 1 to 85,000	8	7½%	5 %	..	1½ — 2	1½ — 2	1¹³/₁₆	..
100,000£	Do. 5 % 1st Mort. Reg. Debs., to 900 of £100, and 901 to 11,000 of £50 red.	..	..	..	..	97 —100	97 —100	..	..
99,261	Edison & Swan United Elec. Light, "A" shares, £3 paid, 1 to 99,261	5	Nil	Nil	..	0 — ¼	0 — ¼	..	..
17,189	Do. do. "A" shares, 01—017,189	5	Nil	Nil	..	¼ — 1½	¼ — 1½	..	..
344,023£	Do. do. 4 % Deb. Stock Red.	100	..	..	..	72 — 77	72 — 77	..	..
100,000£	Do. do. 5 % 2n Deb. Stock Prov. Certs. all pd.	100	..	..	..	76 — 81	76 — 81	..	..
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	..	1⅝ — 1⅞	1⅝ — 1⅞ xd	..	..
31,390	Do. do. 7 % Cum. Pref., 1 to 31,390	2	..	..	..	2⅜ — 3	2⅜ — 3	..	..
82,500£	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock	..	..	..	97 —100	97 —100 xd	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	..	9½ — 10	9½ — 10	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	..	..	..	95 — 98	95 — 98	..	..
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	20 %	20 %	..	13 — 14	11 — 11½	12½	11½
35,000	Do. do. 4½ % Pref.	5	..	..	..	5 — 5½	5 — 5½	..	..
48,050	Do. do. 4½ Mort. Deb. Stock	Stock	..	..	..	108 —112	108 —112	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works	10	10 %	10 %	..	18 — 19	18 — 19	18½	..
800,000£	Do. do. do. 4 % 1st Mort. Deb.	100	..	..	..	100 —103	100 —103	..	..
37,500	†Liverpool Overhead Railway, Ord.	10	1½%	1½%	..	4⅞ — 5	4⅞ — 5	..	..
10,000	† Do. do. Pref. £10 paid	10	..	..	..	10 — 10½	10 — 10½	..	..
37,350	Telegraph Construction and Maintenance	12	20 %	20 %	..	33 — 36	33 — 36	35½	33⅞
150,000£	Do. do. 4 % Deb. Bds., Nos. 1 to 1,500 Red. 1909	100	..	..	..	100 —103	100 —103	..	..
540,000£	Waterloo & City Railway, Ord. Stock	100	3 %	3⅛%	3⅛%	91 — 94	91 — 94	..	..

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ From Manchester Share List.

Bank rate of discount 4 per cent. (September 3rd, 1903).

SHARE LIST OF ELECTRICAL COMPANIES (*continued*).—ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share.	Dividends for the last three years. 1901.	1902.	1903.	Closing Quotations Jan. 27th.	Closing Quotations Feb. 3rd.	Business done week ended Feb. 3rd, 1904. Highest.	Lowest
100,000	Blackheath and Greenwich Dist. Electric Light, Ord...	‡ 1	.. .. ..			¾ — 1	¾ — 1	..	..
50,000	Do. 7 % Pref.	1	.. .. ..			1⅛ — 1¼	.. — ..	..	..
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs. ..	10	.. .. ..			114 —117	114 —117	..	..
20,000	Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000 ..	5	8 % 8 % 10 %			10 — 10½	10¼— 10⅜	..	..
20,000	Do. do. 7 % Cum. Pref. ..	5	.. .. ..			9⅜— 10¼	9¼— 10¼	9	8⅞
250,000	Central Electric Supply 4 % Guar. Deb. Stock	100	.. .. ..			106 —109	. — .	108½	..
60,000	Charing Cross and Strand Electricity Supply	5	10 % 10 % 10 %			8⅜— 9⅛	8½— 9	9 1/16	..
70,000	Do. do. do. 4½% Cum. Pref. ..	5	.. .. ..			5½— 6	5½— 6	..	..
40,000	Do. do. "City Undertaking" 4½% Cum. Pref. ..	5	.. .. ..			4⅜— 5	4⅜— 5	4 15/16	..
40,000	Do. do. 1903	5	.. .. ..			4⅜— 5	.. — ..	..	..
250,000	Do. do. 4 % Deb. Stock Red.	100	.. .. ..			103 —105	103 —105	..	..
44,436	*Chelsea Electricity Supply, Ord.	5	4 % 4½% 5⅛%			5⅛— 6	5⅜— 6¼	6	5⅞
150,000‡	Do. do. % Deb. Stock Red.	Stock	.. .. ..			105 —108	105 —108	..	..
70,595	City of London Electric Lighting, Ord. 40,001—110,595 ..	10	5 % 5 % ..			10¼— 10⅜	10¼— 10⅜	..	..
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	.. .. ..			13 — 14	13 — 14	..	..
400,000‡	Do. 5 % Deb. Stock, Scrip. (iss. at 115) all paid	..	.. .. ..			121 —126	121 —126	..	..
800,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	100	.. .. ..			101 —104	101 —104	103	102½
40,000	County of London & Brush Prov. Electric Lighting, Ord. 1—40,000..	10	4 % 4 % ..			8 — 9	8 — 9	..	..
20,000	Do. do. do. 6 % Pref., 40,001—60,000..	10	.. .. ..			11⅛— 12½	11⅛— 12½	..	..
400,000‡	Do. do. 4½% Deb. Stock	..	.. .. ..			107 —110	107 —110	..	..
250,000	Do. do. 4½% 2nd Deb. Stock	Stock	.. .. ..			99 —102	99 —102	..	..
50,000	Edmundson's Electric Corporation, Ord. Shares	5	7 % 7 % ..			5⅞— 6⅛	5⅞— 6⅛	6 1/16	5⅞
80,000	Do. do. 6 % Cum. Pref.	5	.. .. ..			5⅞— 6⅛	5⅞— 6⅛	..	..
140,000	Do. do. 4½% 1st Mort. Deb. Stock ..	100	.. .. ..			10‹ —10›	103 —106 xd	104½	..
21,000	Kensington and Knightsbridge Electric, Ord.	5	10 % 10 % ..			11 — 12	11 — 12	..	..
90,000	Do. do. do. 4 % Debenture Stock ..	Stock	.. .. ..			102 —105	102 —105	..	..
110,000	London Electric Supply Corporation, Limited, Ord.	3	.. .. ..			1⅞— 2⅛	1⅞— 2⅛	2⅛	2 1/16
49,840	Do. do. do. 6 % Pref.	5	.. .. ..			5⅛— 6	5⅛— 6	5 15/16	..
250,000‡	Do. do. do. 4 % 1st Mort. Deb. Stock Red	Stock	.. .. ..			95 — 98	95 — 98	97½	96½
100,000	Metropolitan Electric Supply, 1 to 100,000	10	6½% 7½% ..			17 — 18	18 — 19	18⅛	17⅛
71,106	Do. do. 4½% Cum. Pref. 1—71,106, £3 paid ..	5	.. .. ..			5⅛— 5⅜	5⅛— 5⅜	..	..
220,000‡	Do. do. 4½% 1st Mort. Deb. Stock	..	.. .. ..			109 —113	109 —113	..	..
250,000‡	Do. do. 3½% Mort. Deb. Stock Red	Stock	.. .. ..			95 — 98	95 — 98	..	..
10,852	Notting Hill Electric Lighting	10	6 % 6 % ..			12½ — 13½	13 — 14	13⅜	..
50 000	Do. do 4 % First Mort. Debs.	100	.. .. ..			99 —102	.. — ..	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14½% 14½% 14½%			14½— 15½	14½— 15½	..	..
20,000	Do. do. do. 7 % Pref. 20,081 to 40,080	5	.. .. ..			8 — 9	8 — 9	..	..
150,000‡	Do. do. do. 3½% Deb. Stock Red ..	100	.. .. ..			98 —101	97 —100	98½	..
12,000	Smithfield Markets Electric Supply, Ord.	5	.. 2½% 4 %			3¼— 3⅜	3½— 3⅝	3⅝	3⅜
50,000	Do. do. do. 4 % Deb. Stock	Stock	.. .. ..			85 — 90	85 — 90 xd	..	..
65,000	South London Electricity Supply, Ord.	5	.. 1½% ..			3¼— 4	3⅜— 4¼	9⅞	..
80,000	Urban Electric Supply, Ord.	5	.. .. ..			4½— 5⅛	4½— 5	..	..
80,000	Do. do. 5 % Cum. Pref.	5	.. .. ..			4½— 5⅛	4½— 5⅛	4 15/16	..
110,000	Westminster Electric Supply, Ord.	5	10½% 12 % 13½%			12½— 13½	12½— 13½	13½	12½
28,141	Do. do. 5 % Cum. Pref.	5	.. .. ..			6 — 6⅞	6 — 6⅞	6	..

* Subject to Founders Shares. ‡ Unless otherwise stated all shares are fully paid.

MARKET QUOTATIONS. Wednesday, February 3rd.

CHEMICALS, &c.

		Latest Price.	Week's Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	..
a ,, Nitric	per cwt.	22/-	..
a ,, Oxalic	per cwt.	32/-	..
a ,, Sulphuric	per cwt.	5/6	..
a Ammoniac, Sal	per cwt.	42/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	..
a ,, ,, ...	per ton	£30	..
a Bleaching powder	per ton	£4 10	..
a Bisulphide of Carbon	per ton	£15	..
a Borax	per ton	£13	..
a Benzole (90 %)	per gal.	7/-	..
a ,, (50/90 %)	per gal.	5/6	..
a Copper Sulphate	per ton	£21 10	..
a Lead, Nitrate	per ton	£24	..
a ,, White Sugar	per ton	£31	..
a ,, Peroxide	per ton	£27 10	..
a Methylated Spirit	per gal.	2/6	..
a Naphtha, Solvent (90% a 160° C).	per gal.	5/6	..
a Potash, Bichromate, in casks ..	per lb.	8d.	..
a ,, Caustic (75/80%).. ..	per ton	£24	..
a ,, Bisulphate	per ton	£35	..
a Shellac	per cwt.	226/-	..
a Sulphate of Magnesia	per ton	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6 10	..
a ,, Recovered	per ton	£5 10	..
a ,, Lump	per ton	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	..
a ,, Crystals	per ton	£8	..
a ,, Bichromate, casks.. ..	per lb.	2½d.	..

METALS, &c.

b Aluminium Ingots, in ton lots ..	per ton	£180	..
b ,, Wire, in ton lots ..	per ton	£168	..
b ,, Sheet, in ton lots ..	per ton	£166	..
m Babbitt's metal ingots	per ton	£43 to £180	..
c Brass (rolled metal 2' to 12') basis	per lb.	7d.	..
c ,, Tube (brazed)	per lb.	9d.	..
c ,, ,, (solid drawn).. ..	per lb.	7⅝d.	..
c ,, Wire, basis..	per lb.	7½d.	..
c Copper Tubes (brazed)	per lb.	9½d.	..
c ,, ,, (solid drawn) ..	per lb.	9⅝d.	..
g Copper Bars (best selected ..	per ton	£73	..

METALS, &c. (*continued*).

		Latest Price,	Week's Inc. or Dec.
g Copper Sheet	per ton	£73	..
g ,, Rod	per ton	£73	..
e ,, (Electrolytic) Bars ..	per ton	£63	..
e ,, ,, Sheets ..	per ton	£74	..
e ,, ,, Rod ..	per ton	£75	..
e ,, ,, H.C. Wire	per lb.	7¼d.	..
f Ebonite Rod	per lb.	3/3	..
f ,, Sheet	per lb.	3/-	..
n German Silver Wire	per lb.	1/6	..
h Gutta-percha fine	per lb.	8/-	..
h India-rubber, Para fine	per lb.	4/4 to 4/4½	inc.
i Iron, Charcoal Sheets	per ton	£18	..
i ,, Pig (Cleveland warrants)	per ton	42/6½	2½d. inc.
i ,, Forgings, according to size	per ton	From £11	..
i ,, Scrap, heavy	per ton	47/6 to 50/-	..
i ,, Wire, galvanised No. 8 ..	per ton	£9 15	..
g Lead, English Ingot	per ton	£11 10 to £11 12 6	7/6 dec.
g ,, ,, Sheet	per ton	£18	..
m Manganin Wire No. 28	per lb.	8/-	..
g Mercury	per bot.	£8 5	..
d Mica (in original cases) small ..	per lb.	4d. to 1/6	..
d ,, ,, ,, medium	per lb.	2/6 to 3/9	..
d ,, ,, ,, large ..	per lb.	4/- to 7/9	..
p Phosphor Bronze, plain castings	per lb.	1/- to 1/2½	..
p ,, rolled bars & rods	per lb.	1/- to 1/3	..
p ,, ,, strip & sheet	per lb.	From 1/1	..
o Platinum	per oz.	£4	..
p Silicium Bronze Wire	per lb.	9d. to 11d.	..
i Steel, Magnet, acc'd'g to desc'p'n	per ton	£58	..
i ,, ,, in bars		£15 to £40	..
g Tin, Block	per ton	£128 to £129	£1 dec.
g ,, Foil	per lb.	1/6	..
n ,, Wire, Nos. 1 to 16	per lb.	1/7½	..
p White Anti-friction Metals— "White Ant" brand ..	per ton	£42 to £62	..
j Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	8d.	..
j ,, 6 lea. Flax	per lb.	5⅝d.	..
j ,, 8 ply 10 lbs. Russian ..	per lb.	4⅛d.	..
j ,, 10 lbs. Russian, single ..	per lb.	4¼d.	..
j ,, 180 lbs. Jute rove ..	per ton	£11	..
k Zinc, Sh's (Vieille Montagne bnd.)	per ton	£24 15	..

Quotations supplied by Messrs.:—*a* G. Boor & Co.; *b* The British Aluminium Co., Ltd.; *c* Thos. Bolton & Sons., Ltd.; *d* F. Wiggins & Sons.; *e* Frederick Smith & Co.; *f* India-Rubber, G.P. and Teleg. Works Co., Ltd.; *g* James & Shakspeare; *h* Edward Till & Co.; *i* Bolling & Lowe; *j* Walter H. Hindley and Co., Ltd.; *k* Morris Ashby, Ltd.; *m* W. T. Glover & Co., Ltd.; *n* P. Ormiston & Sons; *o* Johnson, Matthey & Co., Ltd.; *p* The Phosphor Bronze Co., Ltd.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RETURNS

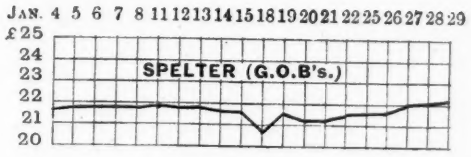
Locality.	Week ending	Receipts for the week. £	£*	No. wks.	Total to date. £	£*	Miles open.	*
Aberdeen	Jan. 30	1,058	+269	35	43,049	+ 8,268	10	—
Birmingham ..	,, 30	5,117	+310	5	25,542	+ 1,891	3½	—
Bournemouth ..	,, 27	777	—	—	—	—	10½	—
Blackburn	,, 29	747	+ 94	—	37,278	+ 1,752	13½	—
Blackpool	Dec. 24	287	— 18	—	37,603	— 159	8½	—
,, —Fleetw'd	Jan. 30	181	— 19	5	781	— 44	7½	—
,, —Lytham	,, 28	141	+126	13	1,875	+ 1,296	7½	—
Bolton	,, 31	1,625	+107	44	80,383	+ 8,799	25	—
Bradford	,, 24	3,404	+544	41	161,242	+21,449	45	—
Brighton	,, 31	688	— 47	—	39,873	—	7½	—
Bristol	,, 29	4,874	+176	—	—	—	28	—
Devonport ..	,, 22	462	+ 98	3	1,468	+ 233	5	—
Dudley—Sto'rb'ge	,, 22	711	+ 96	3	2,192	+ 103	18½	—
Gateshead ..	,, 22	851	+ 95	3	2,692	+ 129	10½	+ ½
Gr'n'k—Pt. Glsgw	,, 22	453	+ 95	3	1,466	+ 172	7½	—
Hartlepool ..	,, 22	248	+ 51	3	773	+ 108	6½	+2
Middleton.. ..	,, 23	237	+ 30	3	746	+ 7	8½	—
Oldham—Ashton	,, 22	479	— 13	3	1,511	— 181	8	—
Potteries	,, 22	1,592	+112	3	4,863	+ 133	28½	—
Southport	,, 22	231	+ 47	3	736	+ 67	5½	—
South Staffs. ..	,, 22	691	+ 87	3	2,164	+ 122	21½	—
Swansea	,, 22	426	+ 29	3	1,397	— 14	5½	—
Wolverhampton..	,, 23	323	+ 22	3	974	— 23	10½	+8
Yorks. Wool Dist.	,, 22	516	—	3	1,609	—	6	—
Miscellaneous ..	,, 22	1,200	—	3	3,751	—	—	—
Burnley	,, 30	808	+154	—	—	—	7½	—
Burton-on-Trent ..	,, 31	282	—	26	9,128	—	8½	—
Cardiff	,, 28	1,779	+294	—	84,183	+21,540	1	—
Chatham & District	,, 28	471	+ 87	4	1,976	+ 427	8·53	—

* Compared with the corresponding period of 1903.

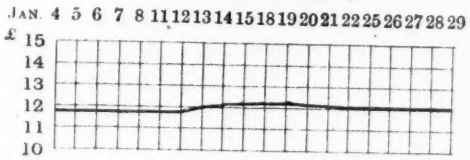
Locality.	Week ending	Receipts for the week. £	£*	No. wks.	Total to date. £	£*	Miles open.	*
Cork	Jan. 28	385	— 3	4	1,595	+ 30	9	—
Dover	,, 30	162	— 8	4	728	— 45	3	—
Dublin	,, 29	4,321	+ 91	5	18,068	+ 748	47	+ ½
East Ham	,, 30	581	+106	—	29,111	+ 8,039	5	+ ½
Glasgow	,, 30	13,420	+1502	35	478,756	+50,931	69½	+7½
Halifax (2 weeks) ..	,, 27	2,160	+283	43	57,986	+ 6,182	31½	+ ½
Huddersfield ..	,, 30	1,105	+131	—	—	—	—	—
Hull	,, 30	1,985	+284	44	83,656	+ 6,196	13	+2
Ilkeston	,, 27	110	—	—	—	—	4	—
Ipswich	,, 23	274	—	—	2,620	—	7·86	—
Isle of Thanet ..	,, 30	199	— 33	4	836	— 52	10½	—
Leeds	,, 30	4,978	+336	—	240,398	+15,154	41	—
Liverpool	,, 23	9,557	+ 668	4	38,406	+ 1,998	103	—
London C. C. ..	,, 30	8,848	+ 782	43½	429,983	+ 76,5 7	39½	—
Manchester	,, 30	10,808	+2632	—	509,782	+273,675	72	—
Newcastle	,, 30	3,506	+ 444	—	—	—	17	—
Portsmouth	,, 30	1,237	+ 10	—	76,596	+ 4,692	14½	—
Salford	,, 25	8,705	+ 884	—	164,283	+ 46,373	30	—
Sheffield	,, 17	4,149	+ 471	3	12,807	+ 1,009	31½	+4
Southampton ..	Dec. 17	844	+ 17	—	—	—	16½	—
Southend-on-Sea ..	Jan. 27	182	+ 15	43	18,787	+ 2,155	8	—
Sunderland	,, 31	1,072	+ 58	44	53,134	+ 2,584	20	+8
Tyneside	,, 27	272	+ 60	4	1,038	+ 258	8·9	+·9
Wolverhampton ..	,, 31	396	+ 10	—	—	—	5½	—
Cen. London Rly...	,, 30	6,992	— 12	5	34,794	+ 118	6	—
City & S. Lon. Rly.	,, 31	3,258	— 57	5	16,019	— 943	6½	—
Dublin—Lucan Rly.	,, 31	92	+ 5	5	405	+ 24	6½	—
L'pool Overh'd Rly.	,, 31	1,505	+ 89	5	7,732	+ 423	6½	—
Mersey Railway ..	,, 30	1,449	+374	4	5,782	+ 1,466	4½	—

METAL MARKET.

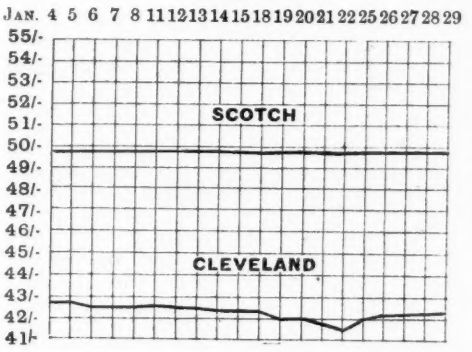
Fluctuations in January.



LEAD (ENGLISH).



IRON.



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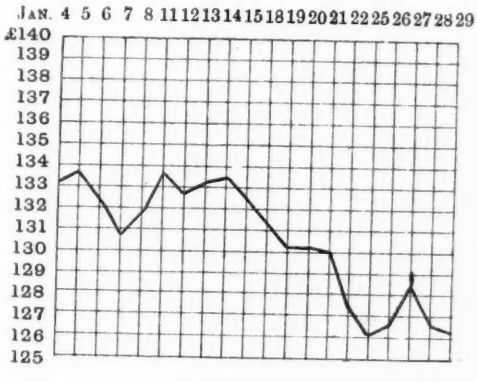
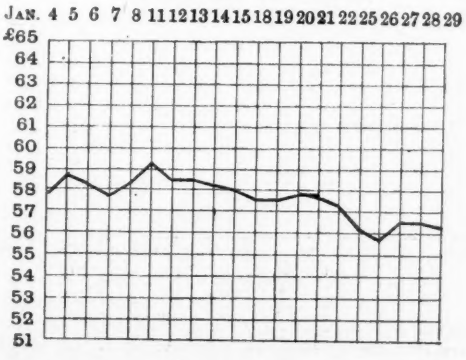


COPPER (G.M.B's.)



APPLICATION OF SINGLE-PHASE ALTERNATING CURRENT FOR TRACTION AND RAILWAY SERVICE.*

By B. G. LAMME.

(*Concluded from page* 197.)

It is surprising that so many are so imbued with the idea of a high power-factor that they are even willing to obtain it by increasing the losses in the apparatus, thus in reality increasing the load on the system. A high power-factor obtained by rheostatic control would represent no more advantageous condition than the use of resistance in series with an induction motor, when running, to increase its power-factor. If a permanent resistance be connected in parallel with an induction motor, it will not increase the power-factor of the motor itself, although any measurements of the input to the motor and resistance will show a higher power-factor than that of the motor itself; but anyone can readily see the absurdity of this combination, although it does raise the power-factor. The use of resistance in series with a motor in order to give higher power-factor at starting would represent a similar absurdity, although it would not be as evident on the face of it.

Leaving out the question of power-factor, the rheostatic method of starting and controlling the motor will, in certain instances, possess advantages over other methods, especially where the loss in the rheostat will average but a small part of the total power expended over a given period. This method of operation should not necessarily be abandoned in all cases, simply because voltage control can be obtained.

The next point, and one which is of considerable interest to the electrical fraternity at large, is the question of commutation in the commutator type of single-phase alternating current motor. In the early times in the electrical business it was discovered that there were many things that could not be done with alternating current, and among these was the commutation of alternating current without excessive sparking. This opinion has become so well established that at the present time many engineers are very doubtful of this point. This opinion is based principally upon experiments in commutation of alternating current, mostly made many years ago, and not upon the theory of commutation itself. In many cases it was considered that the alternating current had some mysterious property which caused sparking when attempts were made to commutate it.

If we go back to the early periods we also find many things which could not be done with direct current, but which are done at the present time. I well remember the time—about 13 years ago—when I was informed by a number of the leading engineers of that time, that it was useless to consider the construction of slotted armatures for railway generators of the then gigantic size of 200 kw. At that time the Westinghouse Co. had a railway armature of this size almost completed, and this advice was very discouraging. But as the armature was so nearly ready to test, it was decided to assemble the machine and find out how badly it would work. The result of the tests was such that the Westinghouse Co. immediately abandoned the surface-wound type of direct-current armature in favour of the slotted type. Other companies probably had similar experiences, for the slotted type is now almost universally used. The above is merely given as an illustration that in direct-current apparatus many early opinions have been abandoned. If one of the 200-h.p. New York Subway motors had been attempted 10 or 12 years ago, conclusions undoubtedly would have been drawn by many engineers, showing the absurdity of attempting to make high-class motors of this size.

In the same way advances in the art have led to a more complete understanding of the underlying principles of commutation among those interested in the design of commutating apparatus, although such knowledge, except in a general form, is limited to a small number of engineers. Very few of all those who handle modern direct-current generators or motors, really know why their machines commutate so much better than some of much older designs which were apparently built on the same lines.

Motor designers with a wide experience in the problem of commutation are now awakening to the fact that the commutation of alternating current does not furnish a set of new and mysterious phenomena, but that the laws which apply to direct-current commutation also apply to alternating-current commutation, and that the problem is principally one of degree. If a continuous current of x amperes have its direction reversed in a coil without sparking as the coil passes under the brush, then there should be no difficulty in reversing this current if it varies periodically from x amperes to zero and up to x amperes again. The trouble is that when opinions on commutation of alternating current were originally formed it was not known how to commutate the current of x amperes.

The principal difficulty in commutation of alternating-current motors has been the presence of local secondary currents in the coils short-circuited by the brushes, such currents being due to pulsating or alternating magnetism through the short-circuited coils. Various arrangements have been tested at different times for lessening the effect of these secondary currents. Such motors are usually built with a comparatively large number of commutator bars, with a very small number of armature turns per bar, to lessen the effect in the short-circuited coil. Very narrow brushes have been tried in order that the period of short circuit may be lessened, and two or more parallel windings forming the so-called "sandwich" type have been tried. These windings lie side by side on the core, but are practically

* New York *Electrical World and Engineer.*

independent of each other and connect to alternate commutator bars, or to every third bar, &c., dependent upon whether two or three parallel sets are used. With two of such parallel windings on a core, a commutator brush of a width slightly less than one bar could be so placed that it would never short-circuit a coil of either winding. In this case the brush passes from one winding to the next, and breaks connection with the first winding before passing to the next bar of the first winding. With this arrangement the short-circuiting of the coils would be diminished, but the type of winding is one which we do not consider satisfactory for railway motors. We consider that this is simply transforming the trouble due to the short-circuited coil to another trouble which would in the end be just as serious—viz., the tendency of such windings to produce blackening and pitting of the commutator bars. Such an arrangement would require very thin brushes if but two parallel windings were used, while with three parallel windings the brush could have a thickness corresponding to two commutator bars.

A number of other devices have been tested at various times by different experimenters, but these are attempts to cure an existing difficulty rather than to lessen or eliminate the cause of the difficulty.

Within the past year or two there has been a great awakening to the possibilities of this problem, with the consequence that there is now a world-wide appreciation of the field of operation for commutator types of single-phase motors which will accomplish results not hitherto attainable. Single-phase motors having good commutating properties are now on the market in this country for the commercial frequency of 25 cycles per second. Higher frequency motors could probably be built with reasonably good results, but as 25 cycles has become a commercial frequency in this country, it is probable that this will become the standard for traction service for single-phase motors.

A single-phase motor having series characteristics having been obtained, it is at once evident that it opens up various methods of control hitherto not utilised in railway service. Having the motor which can be controlled in speed by variations in the voltage supplied to it, then voltage control can at once be obtained due to well-known properties of alternating-current transformers. Such methods of control are dependent upon the use of alternating current, and have not been applied in railway apparatus heretofore, because there was no suitable motor on the market.

Many forms of apparatus for varying the voltage on alternating current circuits have been known and used, and most of these devices permit voltage variations with comparatively small loss in power. Therefore, with an alternating motor with the series characteristics, it is at once evident that we can obtain a traction system in which the power expended is practically proportional to the work done, and therefore the least power will be consumed at starting and at low speeds. This is an ideal condition for railway service, but has not been permissible with the direct-current system, except by great complication.

There are a number of ways in which the various single-phase commutator type of motors can be controlled in speed. With the straight series type, the voltage applied to the terminals can be varied, the field windings can be varied, commutated, &c., or the relative values of armature and field strength may be varied. Also with certain designs of motor, exciting brushes may be placed on the commutator, as we have indicated before, and the voltage applied to these brushes may be varied. All these methods may be used also with the transformer types of motors.

Also by shifting the polarity of the fields to one side or the other of the normal position, the speed can be affected to a greater or less degree, and similar results can be obtained by shifting the armature brushes. The latter method we do not consider a suitable one for traction motors. Also series-parallel control can be used, if desired, just as on direct-current motors, and rheostatic control can also be used. These two methods have practically the same effect on economy as is found with direct-current motors with these methods of control.

Single-phase motors of all types, in common with polyphase induction motors, have one feature which is not shared by direct-current motors—viz., there is an active voltage between the field turns. The alternating magnetic flux through the field of the alternating motor generates an E.M.F. in the field windings, just as in the case of an alternating-current transformer. In the direct-current motor the only voltage in the field coils is that represented by the current flowing against the resistance of the windings. Therefore, in a direct-current motor a short-circuit can occur between one or more turns of the field coil without disastrous effects on the motor. Those who have had a wider experience in the operation of electric railways, and are familiar with the extremely high temperatures momentarily obtained under certain conditions, will appreciate the importance of this feature of the direct-current motor. If direct-current motors were so designed that short circuit between two turns due to overheating or other conditions would disable the motor so that it could not be operated, then it would be necessary to very considerably increase the dimensions of such apparatus in order to get emergency capacity. It will at once be appreciated that the alternating-current motor, with an active voltage between field turns, must be designed to stand heavy overloads without danger of short circuits between field turns. Therefore, either these motors must be designed with more margin of temperature than in direct-current practice, or the windings used must be such as will permit of more insulation between turns than is used in direct-current practice. If such motors are wound for voltages corresponding to direct-current railway practice, then there is greater danger from short circuits in the field than with direct-current motors, and if the motors are wound for comparatively high voltages—say, 3,000 volts, for instance—then the danger from this source is very considerably increased, for in a 3,000-volt motor a large number of comparatively small wires must be used in each coil, and these must be well insulated from each other, and the entire winding must be well insulated from ground. Experience with alternating-current high-voltage stationary motors has shown that such motors are not nearly as safe as those wound for 200 or 400 volts, and we believe that for motors under a car, subjected to the extreme variations of traction service, the danger from short circuits and grounds will be very much greater than in the case of stationary motors. If such traction motors are wound for low voltages, say, 200 volts, approximately, then heavy conductors and but a very small number of turns will be necessary on the field, and each conductor can be separately insulated both from other conductors and from the ground.

Therefore, the alternating current permits the use of low-voltage motors, with the consequent advantageous construction of field coils where the conditions of operation in direct-current practice prevent the use of any lower voltage than that supplied by the line. Troubles from oil and dirt, such as frequently occur with direct-current motors, will become of great importance in alternating-current railway motors wound for very high voltages. We believe that, except for very special cases, it will be found safer to step down the voltage on the car by a transformer, thus supplying the motors with low voltage from the secondary circuit, rather than to wind each motor so that it becomes a transformer subjected directly to the high voltage of the system. In cross-country work, where high voltage would preferably be used, the step-down transformer method also furnishes additional protection from lightning, as it is well known that it is easier to insulate one transformer from lightning than to insulate two or four motors. The question of safety to the passengers and apparatus in the car also should be considered in this matter.

A large number of estimates have been made comparing the general performance, cost, &c., of equipping roads with single-phase alternating-current motors instead of direct-current motors, supplied from rotary converter sub-stations. In all these cases the advantage has appeared decidedly in favour of single-phase, except in a small number of cases where some small limiting condition was placed upon the alternating-current system. If the starts are very infrequent and the running periods long, then the gain in efficiency by elimination of the rheostatic losses at start may be more than compensated for by the slightly lower efficiency of the motors themselves. Where such conditions apply, generally high trolley voltage will be used, and there will be enough gain in efficiency in the transmission and distributing to more than balance the loss in the equipment. Furthermore, the elimination of the rotary converters will furnish a still further gain in efficiency. In estimates made up to the present time, we have, in practically all cases, found higher total efficiency for the single-phase railway than for the direct-current railway with sub-stations. In cross-country work the gain in the transmission and distributing system and the rotary converters compensate for other losses. In city work where starts are very frequent and low speeds necessary at times, the gain by elimination of the rheostatic control has appeared as a very important item in the efficiency.

It thus appears that, while suburban work was once thought to be the most important field for the single-phase railway, it has now become evident that city work, where traffic is very congested in parts of the system, will prove to be one of the best fields for this system. Of course, it is recognised that for heavy railroad service, where all kinds of speeds should be obtained economically, the single-phase railway system will undoubtedly show to great advantage compared with any known direct-current system. But as considerable time will be required to equip any railroad service, it is probable that the single-phase railway system will be well tried out before there is a good opportunity to give it a thorough trial for heavy work. There is no difficulty in designing single-phase motors for sizes up to 300 H.P. or larger, and of sufficiently small dimensions to be used with a single reduction gear on locomotives. There is also no difficulty in designing regulating devices for controlling the power of such motors. For example, a 600-KW. induction regulator manufactured by the General Electric Co. has been in commercial operation at Niagara Falls for many years, and a regulator of this capacity would be sufficient to control a 2,400-H.P. locomotive. The induction regulator furnishes an ideal method for locomotive control, as the voltage supplied to the motors can be varied over a wide range without making or breaking the circuit.

In conclusion, we would say that the subject of the commutator type of motor is now being thoroughly studied by engineers in all the principal manufacturing companies in the world, and there is no longer any question that such motors can be built successfully for commercial service. When it is once shown that such motors are feasible and that, therefore, a new field of development is opened, there is immediately a willingness on the part of most of the manufacturing concerns to undertake the perfection of such apparatus. What is needed in any line of development is a promise of success, and it may be taken as true that success will then be obtained.

AMERICAN CENTRAL ELECTRIC LIGHT AND POWER STATIONS.

AN interesting report on the above has been issued by the United States Government Department of Commerce and Labour. It forms a striking testimony both to American electrical enterprise and to the accessibility which is evidently a feature of American private enterprise in contradistinction to British. From the report we gather that in 1902 the commercial use of electricity for light and power

purposes had extended over some 23 years, and as an instance of its popularity, may be quoted the fact that of 1,892 places having a population of 2,500 and over, 1,511 had one or more central stations, and 1,960 places having a smaller population (*i.e.*, less than 2,500) were in a similar happy position.

These returns, in common with the Continental ones, exhibit in a marked degree the deficiencies of the smaller English communities in the matter of efficient lighting and power facilities; in fact, the communities of under 2,500 population in Great Britain possessing such facilities, are probably less than a dozen. No doubt the American figures largely result from the practice of interurban railways in distributing from their sub-stations.

According to the report there were (in 1902) 252 electric railway companies supplying energy for lighting and power purposes, and if their available returns are included, it appears that the total number of central stations was 3,738; the total income from sale of energy, $90,458,420; number of arc lamps, 419,561; and of incandescent lamps, 19,636,729.

Exclusive of the railway returns, the figures were 2,805 private stations, and 815 municipal stations, with earnings of $77,349,749 and $6,836,856; arc lamps, 334,903 and 50,795 respectively; and incandescent lamp connections, 16,616,593 and 1,577,451 respectively; these figures being given in detail in the Electrical Review, September 4th, 1903.

Although, in point of magnitude, the private enterprises far outweigh the municipal ones, yet the latter appear to be making steady progress, and now amount to 22·5 per cent. of the total number. By comparison the gas industry does not appear to have made much headway, taking into account the fact that it dates from the year 1806. In 1900, there were some 877 gas plants in operation, and their income amounted to some 10 million dollars less than that of the electrical plants.

From the report, it appears that the wide-spread adoption of electric lighting among the smaller towns, accounts for the central electrical stations being so far ahead of gas installations numerically.

In fact, 75 per cent. of the electrical stations are in places having less than 5,000 inhabitants, as compared with 22·8 per cent. in the case of gas plants. It is also worthy of notice that 1,463 electricity stations are operated in conjunction with gas, water or other works, a feature which is practically absent from English practice. In the matter of classifying plants some difficulty appears to have been experienced. The general rule followed was to classify as isolated plants all those which were operated as an adjunct to some other business for which they supplied energy for lighting and power, and only received incidental income from the sale of current.

It is estimated that 45,000 to 50,000 such plants are in operation in the United States.

The private and municipal stations classified according to their different businesses were as follows:—

Private and Municipal Stations Classified According to Character of Service: 1902.

Character of service.	Total.	Private stations.	Municipal stations.
Arc lighting:—			
Commercial or other private ...	2,020	1,667	353
Public	2,522	1,810	712
Incandescent lighting:—			
Commercial or other private ...	3,484	2,752	732
Public	2,491	1,889	602
Motor power:—			
Stationary	1,093	975	118
Electric railway	159	157	2
All other	161	152	9

The cities of New York, Chicago, St. Louis, Boston, Philadelphia and Baltimore possess power plants with a H.P. of 261,640, and 17,600 miles of mains and feeders.

The tables dealing with the financial side of the industry are the least satisfactory portion of the report. The total capital stock and funded debt issued amounted to 627 million dollars, and of this amount 373 millions represent capital stock. Of the latter, 6·4 per cent. is preferred stock, and the remainder ordinary.

The common stock, on which dividends were paid, amounted to 36 per cent. of the total issued, the dividends averaging 4 per cent.

Of the preferred stock, 51 per cent. of the amount issued paid dividends, the average rate being 5·2 per cent., and 223 millions of common and 12 millions preferred stock paid no dividends at all.

Only 589 companies reported paying dividends on either common or preferred stocks, and only 13 paid such dividends on both classes of stock.

Of the 2,049 incorporated companies, 795 paid interest on their bonded indebtedness, with an average rate of interest of 4·8 per cent. Of 656 municipal stations reporting an issue of bonds, 635 paid interest, with an average of 4·5 per cent. on all bonds paying interest.

In the matter of income, it is interesting to note that incandescent lighting is a much more important source of income than arc lighting, these yielding 52 and 28 per cent. respectively of the income of stations operated under private ownership, but for municipal plants the two sources of income are of equal importance, being 48 per cent. of the total in each case. The private stations earn 18 per cent. of their income from miscellaneous electric supply, as compared with about 3 per cent. in the case of municipal stations.

These latter figures indicate a state of affairs nearly opposite to those existing here, as the pioneers of motor supply in Great Britain were the municipalities.

The proportion which the different items form of the total working expenses will be gathered from the following table:—

Percentage that each Item of Expense is of Total, Private and Municipal Stations: 1902.

Items.	Total.	Private stations.	Municipal stations.
Total	100·0	100·0	100·0
Salaries and wages	30·3	29·9	35·8
Supplies, materials and fuel	33·7	32·6	46·2
Rents, taxes, insurance and miscellaneous	17·5	18·2	8·4
Interest on bonds	18·5	19·3	9·6

The particulars relating to the varieties of fuel in use are in striking contrast to the almost universal use of coal over here.

Coal, crude petroleum, natural gas, artificial gas and sundry fuels all figure in the table. Coal, of course, holds the first place with over 80 per cent. of the total fuel costs, but crude petroleum, with a percentage of 7 per cent. in the case of private concerns, gives evidence of either greater appreciation or better facilities for obtaining this form of fuel than obtain here.

The report contains many interesting details of wages and employés.

Of the total number employed, 51 per cent. earn from $1.50 to $2.24 per day.

More than one-half of the engineers receive from $1.50 to $2·49 per day, and more than half the firemen from $1.50 to $2.24 per day.

The great majority of dynamo and switchboard attendants earn from $1 to $2.75 per day.

The percentages given indicate that higher rates of pay are earned in the private stations than in those under municipal control.

For instance, 56 per cent. of all wage earners in private stations receive $2, or over, per day, compared with 41 per cent. in the municipal stations, and 15 per cent. of private station employés earn $2·50 to $2.99 per day, compared with only 9 per cent. in the case of municipal stations.

These figures may only be representative of the greater magnitude of the undertakings conducted by private enterprise in the States.

In connection with the details of the equipments are a number of tables; the particulars of the feeding and distributing networks show that 125,000 miles of main and feeder wires are in use.

However, of this amount, the underground circuits measure only 8,124 miles, or 6½ per cent. of the total, and it will be generally conceded that this almost universal adoption of overhead transmission constitutes the great difference between American and British practice, and at the same time, its comparatively rare adoption over here, whether due to real or to imaginary restrictions, has been one of the greatest deterrents to our electrical development.

Included in the above totals are some 200 miles of electric railway cables, owned by the supply authorities. Of the total H.P. employed in central stations, 78 per cent. represents steam engines and 22 per cent. water-wheels and sundry.

In connection with the steam plant, it appears that 197 engines of over 1,000 H.P. are employed in private stations, and with the exception of 16, all the engines in use by municipal stations are of 500 H.P. or under, amounting to 91 per cent. of the total.

The total number of engines in use is 5,930, with a horse-power of 1,379,941.

In addition to the above, 165 gas engines, of 12,181 H.P., and 365 auxiliary steam engines of 14,454 H.P., are in use.

There are some 1,390 water-wheels in operation, having a horse-power of 438,472, and 85 per cent. of the number are wheels of 500 H.P. or under.

Only 8 per cent. of the wheels have a capacity of 1,000 H.P. or over, but their horse-power forms 47 per cent. of the total for all water-wheels.

The different classes of plant employed will be gathered from the following table:—

Dynamos.—Private and Municipal Stations, and Percentage each Class is of Total: 1902.

Variety of dynamo.	Total.	Private stations.	Municipal stations.	In private stations.	In municipal stations.
Total—					
Number	12,484	10,662	1,822	85·4%	14·6%
Horse-power ...	1,624,980	1,472,996	151,984	90·6%	9·4%
Direct current, constant voltage—					
Number ...	3,823	3,405	418	89·1%	10·9
Horse-power...	442,446	418,913	23,533	94·7%	5·3
Direct current, constant amperage—					
Number ...	3,539	2,957	582	83·6	16·4
Horse-power...	195,531	157,768	37,763	80·7	19·3
Alternating and polyphase current—					
Number ...	5,122	4,300	822	84·0	16·0
Horse-power...	987,003	896,315	90,688	90·8	9·2

The alternating and polyphase generators form the largest proportion of all dynamos installed, and both the total horse-power and individual horse-power of this class of plant are far greater than those of the direct current type.

In addition to the previously-mentioned plant, station equipments include 193 boosters of 18,000 H.P., 132 rotaries of 64,000 H.P. capacity, and 6,881 storage battery cells, with a rated capacity of 16,355 H.P.

Sub-station equipments embrace 8,388 storage battery cells of 25 284 rated H.P., 2 525 transformers of 420,667 H.P., 163 rotaries of 85,556 H.P., and 135 motor-generators and boosters of 140 H.P.

In addition to the transformers mentioned above, 207,151 are installed on consumers' premises, having a total horse-power of 922,774, and making an aggregate of 1,341,441 H.P. of transformers.

Meters on consumers' premises are given as 575,004 mechanical and 7,685 chemical.

In regard to output, the report discloses a state of affairs totally at variance with British practice, as it appears that in the majority of stations no record is kept of this item, and we may, therefore, conclude that works costs do not as a rule trouble American central station engineers.

We are glad to think that our own engineers have for many years appreciated the great value of accurate records of station working as a means of determining the practical efficiency both of the staff and of the plant. The outputs given in the report are largely estimated from the voltage and amperage of the machines, with reference to the hours of operation, and total for the year 2,453,502 652 KW.-hours, and as the total dynamo capacity is about 1,200,000 KW., it would appear that the plant is fully used for about 6 hours daily, or 25 per cent. of its possible output, a figure indicating a great improvement on the conditions obtaining in England.

It further appears that the earnings per KW.-hour are not quite 4 cents, or allowing for 50 per cent. distribution losses, as suggested in the report, the yield would be from 7 to 8 cents per unit, a higher average than obtains over here.

Arc lighting is in a much more developed condition in the States than here, the total number of lamps employed amounting to 385,698. Some 174,000 are classed as private, and 211,725 as public lamps.

For private purposes the enclosed type of lamp outnumbers the open type by about three to one, but for public purposes the open type has the advantage by two to one. Direct-current lamps far outnumber the alternating type. In addition to the above lamps, the street railways operating lighting plants, report 33,863 arcs.

The average annual income for different classes of arc lamp is given as:—Private stations, for commercial use, $49; for public lighting, $83. Municipal stations, for commercial use, $41; for public lighting, $70. These amounts compare very favourably with the cheapest arc lighting over here. The statistics as to incandescent lighting do not call for much comment; we gather that the general introduction of meters is considered to have rendered unnecessary the recording of the number of lamps in circuit, and the results are, therefore, only approximate: also that meters are in use by practically all stations, for at least a part of their output, the other part being supplied on rates based on the number of lamps and H.P. of motors connected. These particulars throw an interesting sidelight on American methods of conducting the commercial department of the central station.

Motors connected up to private plants, equal 99,000, of 620,000 H.P., and to municipal plants, 1,962, with a capacity of 5,403 H.P. These figures again are only approximate, and no data as to cost of energy are given.

The number of railway motor-cars served was 2,379, and all but nine were reported by private stations..

The statistics, as a whole, reveal the greater enterprise of American engineers, aided, no doubt, by freedom from restrictive legislation, and the adoption of constructional methods quite inadmissible in this country; but they also reveal considerable shortcomings in the chief engineer's departments, where such items as works costs, lamp and motor connections and station data, are evidently not appreciated at their true worth.

THE GERMAN ELECTRICAL INDUSTRY.

THE past year has been a period of amalgamations in the electrical industry, and the New Year has opened with the prospect of further fusions taking place at no distant date. A considerable amount of activity prevails in the heavy branches, but prices are low and not very remunerative.

Siemens & Halske Co.—After speeches had been delivered by Herr Spiecker and Herr Wilhelm von Siemens, the family circle of 12 shareholders who were present at the annual meeting which was held in Berlin on December 29th, approved the report and accounts for the year 1902-3, and sanctioned the amalgamation of the company's heavy electrical engineering branch in Austria with that of the Austrian Schuckert Co. under the title of the Austrian Siemens-Schuckert Works Co., with a capital of £720,000. The report stated that the improvement in trade had continued and manifested itself in the receipt of considerably larger orders, but the prices left much to be desired. With regard to the high-speed experiments on the Marienfeld-Zossen military railway, the recent trials had shown that with certain precautions a speed of 125 miles an hour could be attained, and that electrical power, amounting to some thousands of horse-power, could be safely transmitted, free of interruption, to cars travelling at such a high speed. The accounts for the past two years may be summarised as follows:—

	1902-3.	1901-2.
Gross profits	£407,748	£386,808
Working expenses, interest and depreciation	186,051	197,526
Net profits	221 697	189 282
Dividend	5%	4%

It will be remembered that the Siemens & Halske Co. nearly a year ago transferred to the Siemens-Schuckert Works Co. its dynamo works at Charlottenburg, the Westend cable factory, the lighting and power departments, and the electric railway branch. The transfer took place on April 1st, 1903, and from a report of the amalgamated company for the first four months' operations, it appears that considerable activity prevailed during that period. In addition to the value of the orders received being much larger than under independent working, special success attended the recent introduction of electric winding engines for main shafts on the Ilgner-Siemens-Schuckert system, the driving of iron and steel rolling mills, and the sale of Liliputian arc lamps, which are intended as substitutes for large incandescent lamps. The balance-sheet of the joint company for the four months is not accompanied by a profit and loss account, and it is, therefore, impossible to see the amount of the profits earned and their apportionment between the two original companies. The information is also not ascertainable from the profit and loss account of the Siemens & Halske Company. On this point, Director Spiecker stated at the annual meeting that it had not been usual for the company in the past to indicate the individual profits of each department, and it would not be consulting the interests of the company to depart from that practice at the present time, and, for the same reason, it would be injudicious and prejudicial to differentiate the profits earned by the transferred heavy electrical engineering departments from those branches still in the hands of the company. The director added, however, that it was intended to specify the amount written off for depreciation by the amalgamated company in the future, and that the sum provided for this purpose for the four months which comprised the "first business year" reached £33,678. The details of the amalgamation of the main portion of the Austrian branch with that of the Austrian Schuckert Co., to which reference has previously been made, were placed before and approved by the meeting. Of the total capital of £720,000 of the Austrian Siemens-Schuckert Works Co., the Berlin Siemens and Halske Co. will hold about £500,000; and as the shareholders in the Austrian Schuckert Co. have already sanctioned the combination, the scheme may be regarded as practically carried into effect.

Siemens-Schuckert Works.—The financial year of this company, which acquired the heavy electrical engineering departments of the Siemens & Halske Co. and the entire manufacturing undertaking of the Schuckert Co., commences on August 1st, and a statement has been prepared relating to the four months dating from the day of transfer—namely, April 1st—to July 31st, 1903. The statement summarises the assets and liabilities of the company, which has a share capital of £4,500,000, of which £500,000 had not been requisitioned by the end of July, but a profit and loss account is not appended to the balance-sheet. It appears that both the works at Charlottenburg and Nuremburg were well employed during the four months, and the process of amalgamating the 42 branch offices in Germany was proceeded with. The future of the steam turbine is recognised, and it is stated that rivals to the Parsons type may shortly be expected from several quarters.

The Schuckert Co.—Notwithstanding the transfer of the manufacturing departments to the Siemens-Schuckert Works Co., the Nuremburg Co. continues in existence in the interests of the original shareholders for the purpose of apportioning its share of the profits received from the amalgamated company, and for its financial investments and its intimate relations with the Continental Co. for Electrical Enterprises. This fact, and the desirability of bringing the financial year into line with that of the combined company, will explain the issue by the directors of the Schuckert Co. of a statement giving the results for the period of four months ended July 31st, 1903. The statement shows a profit of £32,040 from investments, securities and participations, which becomes increased to £38,383 by including the balance brought forward. As against this, expenses, interest charges and depreciation, amount to £41,225, while expenses and corrections in connection with the amalgamation with the Siemens & Halske Co. represent a total charge which increases the deficit to £35,094. This is covered by drawing upon the reserve fund, which thereby becomes reduced to £30,534.

The Union Electricity Co.—The business year of this company, which has a share capital of £1,200,000, has been changed so as to harmonise with that of the Allgemeine Elektricitäts Gesellschaft, with which a community of interests has been established for a period of 35 years, and as a consequence the recently issued report only covers the six months ended with June 30th, 1903. The report states that the rearrangement of branches as a result of this understanding involved the company in considerable expense, that the accounts for large works and deliveries effected in the spring and summer only fall due in the autumn and winter, and that considerable sums had to be written off for depreciation of securities. These causes resulted in a loss of £127,496, which has been covered by drawing upon the reserve fund. This compares with a dividend of 4 per cent. in 1901-02, 6 per cent. in 1900-01, and 10 per cent. in each of the two preceding years. The report mentions that the agreement with the Allgemeine Co. commenced on August 1st, that the electric tramway orders on hand were 50 per cent. higher than at the corresponding period of 1902, and that instructions had been received to equip a 12-mile secondary railway with the new single-phase alternating-current motor. The accounts were passed at the recent general meeting without any noteworthy

discussion. At the assembly of the Allgemeine Co., it was stated that the reports published concerning a complete absorption of the Union Co. were premature, and that a scheme for that purpose had not yet been placed before the board of supervision. Since then, however, a scheme has been prepared, and the Union Co. will shortly be entirely merged into the Allgemeine Co.

The Helios Co.—The exhaustive scheme of financial reorganisation, which was carried into effect in 1902, has apparently not changed the fortunes of this Cologne company, which has closed the year 1902-3 with a further loss of £67,850. As reorganised, and with the additional capital subscribed, the company's share and bonded capital exceeded £1,200,000, and the reconstruction resulted in a book profit of £796,300. This large sum has now disappeared, as £442,650 was appropriated to meet the deficit in 1901-2, £276,450 was written off for extraordinary depreciation, and £9,200 was expended in providing for the outlay on reorganisation, while the heavy loss of the past financial year practically absorbs the balance of the paper profits. Thus the hopes which were entertained that the reconstruction of the concern would lead to better results have not in any way been realised. The directors attribute the unfavourable position of affairs during the year to the complete cessation of new orders, owing to the unsatisfactory situation of the company as revealed by the scheme of reorganisation, and to the discussion of the facts in the newspapers. Coming to a later date, the directors' report states that, although an improvement in prices has not yet taken place, the restoration of confidence in the company is noticeable in the constantly increasing orders, both in number and extent, and that the augmented turnover has been effected notwithstanding a considerably reduced sales organisation. As a consequence, it is expected that the company will, in the future at least, be able to meet expenses and the payment of interest on the bonds, but any distribution of profits cannot be anticipated until normal conditions have been brought about by an understanding in regard to prices, which is considered to be imperatively necessary between the large electrical firms. At the general meeting held at Cologne on December 29th, Herr Pfannkuch, the general director, informed the shareholders that all departments of the works were well employed, but that prices left much to be desired, and a divided could also not be reckoned upon for the current year. An understanding between the various electrical companies with which the Helios Co. was prepared to associate itself was lacking, and the company must continue to fight until such an arrangement was arrived at. With regard to the heavy loss incurred in the past year, the general director remarked that a considerable sum had to be written off for depreciation, although that did not include the shares held in the St. Petersburg Co., but the large sum allocated for that purpose in the case of the other works probably compensated for the omission to a certain extent.

Berliner Telephone Works.—This company, whose share capital has been increased to £100,000, succeeded in improving its position during 1902-3. The accounts show net profits amounting to £8,150, as compared with a loss of £3,456 in the previous year, and a dividend at the rate of 6 per cent. has just been declared. The invoice value of the turnover increased by 57 per cent. over that of 1901-2. The report states that apart from the Paris Co. all the branches yielded a profit, and the experience gained so far in the current year leads to the conclusion that the future will also be remunerative.

AN INQUIRY INTO THE WORKING OF WATER SOFTENERS.

The above is the title of a paper by Mr. Stromeyer and Mr. W. B. Baron read before the Institution of Mechanical Engineers on December 18th. The authors dispute the prevalent idea that scale seriously reduces the efficiency of a boiler, because the presence of scale on the heavily-worked portions raises the duty on the less heavily-loaded surfaces, and the net result is not, after all, so bad, but if the highly-heated plates are scaled badly, they may become dangerously overheated, and the plates may be weakened to destruction temperature so that a furnace might collapse. It is fortunate that scale does not readily cling to furnaces. It becomes detached by expansion movements, or it becomes damp next the plate, and is blown off by steam pressure.

Scale increases the wear and tear of a boiler, because it allows the plates to become hotter, and they cool as before when the furnace door is opened. Grease also has bad effects, and both it and scale-forming salts ought to be removed from water before it is allowed inside a boiler. Even soluble non-scale-forming salts are to be guarded against, for they will concentrate dangerously, and yet they may remain unsuspected until disaster occurs.

The authors then proceed to deal briefly with the three chief scale producers—carbonate of lime, sulphate of lime and carbonate of magnesia, showing how the first is precipitated on homœopathic lines by lime, the second by carbonate of soda, and the third by lime. The third salt, however, becomes hydrate of magnesia, and is troublesome as a clogger of filters, the hydrate being gelatinous.

Grease, of course, is the most dangerous of all boiler-plate coatings, having an effect out of all ratio to its thickness, a mere film of grease causing serious overheating. Grease can only be removed partially by filters. Separators are more efficient, but not perfect.

The only effective method is to add mineral matter in solution, and precipitate chemically, the grease sticking to the precipitate. Carbonate of lime scale is due to the insolubility of the salt in boiling water. Sulphate scale, on the other hand, is due to concentration.

Magnesia as carbonate is like calcium carbonate, but sulphate and other salts of magnesia are very soluble, but are corrosive. We are told to treat them by carbonate of soda. This precipitates them, and produces sulphate of soda, which is also very soluble, but must, of course, not be allowed to concentrate to depositing point.

Greasy water may be mixed with hard water, the grease going with the precipitates. With coal at 12s. per ton it costs 6d. to heat 1,000 gallons of water from 60° to 212° F. To soften a carbonate water without boiling it costs 1·53d. per 1,000 gallons with caustic soda at 12s. 6d. per cwt., and 0·09d. with caustic lime at 1s. per cwt., when the hardness is equal to 6 grains of CO_2 per gallon.

Permanent hardness, however, requires a soda salt, and is best dealt with by the carbonate of soda formed by precipitating the carbonate of lime by means of caustic soda. This double reaction was first recommended by Dr. Angus Smith in a report to the Manchester Steam Users' Association many years ago, and reprinted in one of the Association's Reports a few years ago. Soda ash of 58 per cent. strength costs 5s. 6d. per cwt., and will soften 1,000 gallons from a permanent or sulphate hardness of 10° at a cost of 0·88d.

Some water softeners produce caustic soda in reality by mixing caustic lime and soda carbonate in their mixers. Thus produced the caustic soda costs about 6s. per cwt. The cost of softening is thus made up of chemicals, interest and labour, and as a comparison between a boiler fed with softened water and boilers fed with sedimentary water, a table of total annual charges is given, which shows that the annual cost of the first is one-half to one-third the cost of the second; the clean fed boiler lasting 50 years, and the worst of the other class lasting only 15 years. The very minimum saving of only £30 per annum, capitalised at 5 per cent., will show £600, whereas the cost of a water softener is about £100 to £200 per boiler. There is thus a great economy in softening, and the figures given do not include the disturbance of business inevitable when a boiler is removed.

There are, of course, difficulties incidental to softening, for the freshly separated lime salts are in a colloidal state and do not filter readily, a state of things that may be remedied by the free admixture of old deposit with the newly softened water so as to provide nuclei of crystallisation to promote the same process in the new precipitates. No mention is made in the paper of the process of mixing a little organic matter in the water, and using a little alum or other astringent, as alumino ferric, so as to coagulate the organic matter, and assist in precipating all the solids, the coagulate carrying down the finely suspended particles of lime carbonate, &c. Thames river water, and other pond or river waters are frequently full of organic matter and cannot be treated successfully without the use of some coagulant.

Many water softeners rely for speed of sedimentation upon the division of the water into thin films. According to Wanklyn's tests it requires 25 minutes for precipitate to settle through $\frac{3}{4}$-in. of water, and eight hours to settle through 20 in., but experiments have not been made on hot water.

In the absence of divisions, it is a good plan to draw water off the tank by a float placed at the end of the tank remote from the inlet, and if a tank can be warmed so that the inlet water is colder than the water in the tank, the inlet may be at the bottom of the tank, and settlement will be more effective.

The fact that settlement is promoted by heat is shown by the deposits which occur when treated water becomes heated in pipes; injectors, for example, being liable to choke with deposit. Purposely to generate heat for aiding precipitation may be costly, but there are many sources of heat that might be employed if only the gentle warmth of circulation water passed in a coil through the tanks. Where special apparatus is not wanted, water can be softened in tanks, for which two with a day's supply each are desirable. Each tank of water is run in on the top of the necessary chemicals, and the whole stirred up with the residue of previous operations. The float draw off then simply draws off the clear top water.

It is better in practice to overdo the process of softening, and cure the overdose by further hard water, than to practise the converse process.

While some of the foregoing points might with advantage have been enumerated, the paper is very good as it stands, and it contains descriptions of many of the more usual apparatus and their action, and in an appendix a table of solubilities of lime and lime sulphate, and, finally, an extended table of analyses, the treatment necessary and the apparatus employed. A final appendix gives some of the tests with soap solution and phenolpthalein.

The paper should prove a useful one, because though there is nothing new in it, there is brought together much information into small bulk and in a manner that should prove of service to steam users. Dr. Angus Smith's rendering of the Clarke process has been long before the world, and the simple chemistry for ordinary scale has been before engineers freely for many years, yet how few there are who benefit from this knowledge, even to the extent of having the simple chemical reactions carried out in plain tanks?

ROYAL COMMISSION ON LONDON TRAFFIC.

At the sitting held on January 28th evidence was given by Mr. W. G. Shadbake, chairman of the Leyton U.D.C., respecting the need for inter-communication facilities being provided with other districts, and stated that this Council was proposing to purchase certain sections of private lines for the purpose of connecting with

the West Ham and Walthamstow lines, thus affording alternative routes to Bow and North-east London.

Mr. R. H. SCOTTER, C.E., light railways expert, said, in the course of interesting evidence, that the large reforms which would affect large areas, where many divergent interests were included, must be carried out by some higher authority than any one of the local elements could furnish. He referred especially to the light railway system of Belgium, the underground railway system of Paris, the abolition of accumulator traction in Germany, the experiments upon the military railway at Zossen, as examples of work carried out in a national spirit. One of the latest illustrations of this was the action of the Prussian Minister of Railways in extending the franchise of the Great Berlin Tramway from 1922 to 1949, although the Berlin City Council had decided to run all its street railways under municipal control. Although the idea of municipal control was rapidly spreading on the Continent, it must not be confounded with what seemed to be the ideal of the ordinary English local authority, viz., to construct and work the tramways within its limited area without any reference to the rest of the world. Continental municipalities were, as a rule, content to construct the permanent way and to grant a long lease to a private company or companies to equip and work the line. Further, it was the universal practice to grant the greatest possible facilities to light railways and local railway companies to bring passengers and goods from the country into the towns, and *vice versâ*. Except in England, he had found no local inquiry such as that held by the Light Railway Commission, and from the success which had attended this departure, he ventured to suggest the advisability of constituting a similar tribunal for reference of all secondary lines to London, including tramways, light railways, urban tubes and subways. He also suggested the inclusion, on the tribunal, of expert individuals of world-wide experience, able to advise both theoretically and practically upon the various traffic problems as they came before the Commission. Local veto, as defined by the Tramways Act and Standing Orders, did not exist on the Continent. The local authority could suggest any number of improvements or alterations in schemes submitted, all of which suggestions would receive full consideration by the higher authority, but it could not absolutely prevent any scheme from going forward. In many States it was the duty of the Municipal or Provincial Council to itself submit the scheme to the Government department. Witness proceeded to state the various points of difference between Continental countries and England in procedure with regard to concessions, and amongst other points said that in Dresden the Government had constructed an electric railway, which was being worked by a company. In Bavaria permission to draw up a scheme had first to be obtained from the Home Secretary. In Italy a Royal decree was necessary for all tramways on national roads, but in the provinces local consent had to be obtained for lines strictly within their areas. In Belgium light railways were in the hands of the National Society, which investigated every application from a district for a light railway. In Brussels, since 1899, the State had taken up the matter of tramway concessions, and, regulating the matter from the point of view of general interest, had put an end to the divergent views of the communal authorities. Very few instances of actual financial help to concessionnaires had come under his notice, but there were various systems of indirect help in the way of remitting taxation for the first few years, granting land, or repairing roads for a limited term. The price of land was invariably fixed by the valuation of an expert, or, failing an agreement with his award, by arbitration. In no case had he found the principle of "betterment" allowed to influence the price. The length of time allowed to the concessionnaire differed considerably in different countries, and it was invariably longer than English practice, either under the Tramways Act of 1870, or the Light Railways Orders granted under the Light Railways Act of 1896. In Belgium the concessions granted to the Chemins de Fer Vicinaux were in perpetuity, and the National Society could thus continue its work without fear of coming dissolution. In England, where light railways were laid on land acquired by the companies, the same practice generally obtained. In Turkey the permanent way and fixtures would revert to the Government at the end of a period fixed by experts as sufficiently long to admit of amortisation of capital invested, and material and equipment could be paid for at a valuer's price. At the end of 40 years in Leipzig the entire plant would be taken over by the Corporation without compensation, but landed property, buildings and the machinery contained therein would be excepted. In Bavaria, after 99 years, the tramway became the property of the Government without compensation. In Italy, in 60 or 70 years, according to the character of the line, the whole concession became the property of the granting authority. In Alsace-Loraine the Government could purchase at any time by paying in Alsace 20 times, and in Baden 25 times, the net annual profits for the previous five years. In Stuttgart the parish councils might purchase on the basis of open negotiations after 48 years. In Italy, Leipzig, Aachen and Stuggart, special taxes had to be paid in addition to local and Government taxes. Hamburg, being a free town, could sanction the construction of tramways without application to the Imperial Government.

On Friday last, evidence was given by Mr. H. L. CRIPPS, of the firm of Messrs. Dyson & Co., Parliamentary agents. Witness said he had been connected with Parliamentary promotion work for 30 years, and he did not think any improvement was needed on the present procedure. During the whole of his 30 years' experience, he had not known of a single case where substantial injustice had been done, and, speaking generally, the results had been favourable to promoters rather than to opponents. If any change was necessary, it was in the direction of further safeguarding the interests of those who wished to oppose schemes put forward. He thought there was a great advantage in Bills having to come before committees of both Houses of Parliament, as he did not think any great scheme could be properly considered and dealt with before one committee. With regard to the question of locomotion in London in general, he did not think it was any more complicated than it was 20 or 30 years ago, especially as regarded tramways and railways, although there was no doubt that the regulation of the traffic in the streets was a more complex problem than it was years ago. He did not agree with the proposal to form a special tribunal to deal with schemes for London traffic, which would take the sanctioning of schemes out of the hands of Parliament. If such a tribunal was to be created, it should merely report upon the schemes placed before it, and they should go to Parliament to be finally sanctioned.

Questioned with regard to Standing Order No. 22 under which a promoter must obtain the consent of the local authority before proceeding to lay a tramway scheme before Parliament, the witness said he would advocate the abolition of that clause. He thought that a promoter ought to be able to bring forward a scheme, without it being subject to the veto of the local authority. Under the present arrangement local authorities made all sorts of bargainings with promoters in order to obtain their consent, and such a practice was not good for the public.

By Sir FRANCIS HOPWOOD: The power of veto was very objectionable, for instance, in the case of a tramway running through several districts—if the central local authority refused its consent, it would have the effect of breaking the whole link.

INSTITUTION OF ELECTRICAL ENGINEERS.

ALTERNATORS IN PARALLEL.

By H. BOHLE.

(*Abstract of paper read at Leeds, January 21st*, 1904.)

WHEN two alternators are run in parallel and subject to changes of load, temporary variations of terminal pressures take place, which will usually not be alike for each machine, owing to differences in the governing of the prime movers and differences in the construction of the alternators themselves.

If for any reason whatever, on variation of load, one machine generates a higher voltage than the other, which will be accompanied by difference of speeds, a local current will be set up in the circuit containing the two armatures. This current will be a lagging current in one machine, and a leading one in the other. Now this current is caused by an E.M.F. which is the resultant of the two E.M.Fs. of the machines, and it lags nearly 90° behind this resultant E.M.F., since the circuit of the two armatures forms an almost entirely inductive load. As far as the actual E.M.Fs. of the alternators are concerned, the current leads over that of higher E.M.F., and lags behind that of lower E.M.F., with the result that the field of the latter is weakened, and that of the former strengthened; the speed of the former is, therefore, increased while that of the latter is diminished.

The momentum of the armature of each machine will carry each past the point at which their speeds are identical, so that the one which previously had the lower speed will attain the higher speed of the two. It is thus seen that the local current has the effect of a spring upon the armatures, and causes their speeds to oscillate about the position of equal speeds. For this reason the local current is called a *synchronising current*. The oscillations produced by the synchronising current are called *free oscillations*. The periodic time of these free oscillations depends upon the moments of inertia and upon the synchronising force due to the synchronising current.

Suppose, now, that the two alternators were driven by prime movers of the reciprocating type, and that the periodicity of the impulses due to the engine coincided exactly with the periodicity of the free oscillations. It is easily seen that under these circumstances the two alternators would quickly be thrown completely out of step. In the absence of free oscillations, that is, on open circuit, the prime movers would not drive the alternators at a constant speed, but at a variable speed which would oscillate about a certain mean value. These oscillations are called *forced oscillations*.

If the forced and free oscillations have the same periodic time, the latter become so accentuated as to throw the alternators out of synchronism altogether. This phenomenon is called "*resonance*."

In a good engine the difference between the maximum and minimum velocities will be but small.

The ratio of the difference between these two speeds to the mean speed is called the "*coefficient of speed variation*." This coefficient should in no case exceed 0·01.

If resonance occurs, it can be cured by altering the mass of the fly-wheel, preferably by increasing it, though if the coefficient of speed variation is less than 0·005, the mass may be diminished, the object to be attained being, of course, to make the periodic times of the free and forced oscillations differ in value.

There are other means which will enable alternators to run in parallel, even if the free and forced oscillations have approximately the same periodic time. What must be done is to arrange that the free oscillations die out before they obtain fresh aid from the impulses upon the pistons. In other words, the oscillations must be quickly and effectively damped, which may be done mechanically or magnetically.

Mechanical damping is obtained by means of friction couplings arranged between the alternator shaft and engine shaft, or by driving the alternators by belts. In fact, belt-driven alternators

have been found very suitable for parallel running, as the slip and the tension of the belt neutralise the variations in the speed.

Direct driven steam plants possess, however, many advantages over belt-driven sets, and these being chiefly used, magnetic damping is practically the only remedy.

A well known damping apparatus is that of Hutin and Leblanc. The field magnets produce currents in the turns of the stator, setting up stator fields which rotate at the same rate as the ordinary field. As long as the rotor is running synchronously its fields will be in step with the stator fields (the rotor is the moving field magnet wheel), and copper rods, fixed near the circumference of the pole shoes, will not cut across any lines of force. When, however, the rotor is oscillating, we have a field set up by the local current in the circuit of the armatures which will always be in synchronism, and the copper rods cut across the lines of this field, producing strong damping currents. The best damping effect would be obtained by using solid rings. This, however, would reduce the iron too much.

A machine with a damper, or amortisseur, of this kind may be considered as an asynchronous and synchronous machine at the same time. The amortisseur corresponds to the cage rotor. The slip is, however, not always positive, but alternately positive and negative. The turning moment produced by an asynchronous motor is taken from the network, but energy is supplied to the network when the motor runs past synchronism, or when the slip is negative. The energy of a synchronous machine is proportioned to its lead in regard to the network, or its fluctuation of energy is proportional to the lead.

If, on account of sufficient fly-wheel masses, the fluctuations of energy supplied to the network are smaller than the fluctuations of energy of the crank effort diagram, damping is useless. But if there are small fly-wheel masses, so that the fluctuations into the network are larger than the fluctuations of energy of the crank effort diagram, damping will give good results. In other words:—Use damping with multi-crank sets, but not with single-crank sets.

Now consider how far the compounding of alternators for constant pressure will affect parallel working. Up to the present compounding has been done by converting part of the main current, the direct current being then sent through an auxiliary winding on the field magnets. But compounding is also dependent upon the phase difference, and some very ingenious devices have been invented to overcome this difficulty. These devices have, however, not come into extensive use on account of their complications.

A neat and simple method is due to Mr. Heyland. He uses an ordinary synchronous generator, whose rotor is provided (besides its ordinary winding) with a kind of secondary winding, similar to a Leblanc amortisseur, this winding ending in a commutator. By means of brushes current may be passed through this special winding. If now these brushes are joined in series with the stator winding, then by means of proper proportions and suitable brush positions a field can be set up which neutralises the stator reaction entirely, and as this winding rotates in synchronism with the field no E.M.F. of self-induction will be produced, so that the pressure at the brushes need only be high enough to overcome the ohmic resistance.

Compounding of generators is only suitable for single machines, parallel working with several compounded machines being impossible. The maximum number will be two, with equalisers, because parallel working is only possible when synchronising currents are allowed to flow. Where several machines are to be run in parallel, it is, however, sufficient to have two or even only one machine compounded. All wattless currents will then be taken over by the compounded machine, keeping the network pressure constant, while the uncompounded generators will deliver pure watt-currents. The same thing applies to a generator which feeds motors. If the former is compounded, the latter should not be so.

COAL CONSUMPTION IN CENTRAL STATIONS.

By A. S. Giles, Member.

(*Abstract of Paper read at Manchester, January 19th*, 1904.)

The author first points out that in an ordinary weaving and spinning mill an indicated H.P.-hour can be produced for about 2 lbs. of good coal, equivalent to 0·125d. per unit for fuel cost. The load factor may be taken at 33 per cent., and the losses are small; we may add that the load is exceedingly uniform—an important consideration. In order to emulate this example, the author advocates a careful study of generating costs, item by item.

Every central station engineer should make his own calorific tests of the coal supplies available, in conjunction with a practical running test of some days' duration.

Under the second heading in the paper—coal handling—Mr. Giles says: "If the central station is a small one, burning, say, 50 tons per week, mechanical stokers will show very little gain over hand firing, unless it is necessary to avoid all smoke, or to burn a very low-class fuel. In large central stations, however, mechanical stokers are most satisfactory, for not only can a cheaper coal be used than with hand firing, but the economy of labour in employing these machines in conjunction with coal elevating and conveying plant, may reach sometimes 30 to 40 per cent. over hand firing. Whilst the advantages in a large station of the fuel being delivered to the furnaces with regularity, the even firing, and consequently better covering of the grate bars, with closed fire doors, must ensure a higher boiler efficiency."

Under the heading of combustion, &c., it is stated in illustration of the necessity of studying the composition of the flue gases that "if carbon be consumed to CO_2, it produces 14,650 B.Th.U. per lb. —if consumed to CO it produces 4,400 B.Th.U. per lb."

A table follows, giving the percentage loss of heat for different percentage volumes of CO_2 in the flue gases:—

Percentage CO_2 in flue gas by volume	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Percentage loss in coal	90	60	45	36	30	26	23	20	18	16	15	14	13	12

Evidently, then, the composition of flue gases is not one to be treated lightly or ignored by the central station engineer who wishes to secure the greatest possible economy in working.

In regard to boiler covering, it was stated that careful experiments had shown that the loss by radiation per hour per square foot of external surface on a bare pipe at a steam pressure of 135 lbs. was 903 B.Th.U. Non-conducting covering had been found to reduce this loss to 150 B.Th.U. The author added a statement, not in his paper, that according to a rough calculation he had made, the loss per square foot of bare pipe per annum represented half a ton of coal; this means a very considerable cost in a large central station, even reckoning only those portions of flanges or valves which are almost unavoidably left bare. The author advocates the use of superheat to minimise condensation losses.

The guaranteed steam consumption of modern high-speed engines, he says, is practically the same as that of "Corliss" engines.

In conclusion, the author "ventures to suggest that central station engineers could, with advantage, carefully study the chain of heat losses in their respective stations in order that improvements, however small individually, may be made, and thus utilise the fuel with greater economy." Results of fuel consumption tests made by the author at his own station are given, the final result being:—

Pounds of coal per square foot of grate area = 29·2
Pounds of coal per B.T.U. generated ... = 3·35
Cost of coal per B.T.U. ... ... = ·125d.

A table of "Blackburn fuel tests" giving "actual working test" and "calorimeter test" on various qualities of coal, and a table of "coal consumption in electricity supply central stations," are included in the paper. The latter particulars are furnished from 26 lighting or combined lighting and traction stations and three tramway generating stations, and are very interesting, showing that, though some stations reduce their cost of coal per unit sold by using a very cheap coal, others working under different conditions arrive at similar figures while using coal costing considerably more.

Three sets of curves showing coal consumption and cost in relation to load factor for Blackburn, Salford and Southport for 1903 were supplied by the author with his paper.

Discussion.

The chairman, Mr. Cowan, referring to cost of coal per unit, quoted figures as follows:—

Col. Crompton, 1887 ... ... 0·27d.
Mr. Hammond, 1894 ... ... 0·2d.

He noted from Table B. in the paper that at St. Helens and Glasgow the figures were 0·18d. and 0·13d. respectively, both showing an improvement on those he had just quoted. The best figure he knew of was at Messrs. Cadbury's chocolate works, this being 0·125d. per unit, though in this case a gas engine was employed. Mr. Giles, in his paper, had not referred at all to the utilisation of hydrogen in the coal, and a case was quoted by the speaker where the economisers, instead of having water, had air passed through them, this hot air then being used for the combustion of the coal, and it was found that a considerable increase of efficiency resulted due to hotter furnaces. On the question of heat transmission, Mr. Cowan referred to copper fire-box crowns, but thought that although copper is a much better conductor than iron, yet if the copper is at all dirty, there is not much to choose between them, and he agreed with Mr. Giles as to the importance of keeping all parts of the boilers clean, and free from soot, scab, grease, or dirt of any kind. In regard to lagging of steam pipes and boiler coverings, Mr. Geipel was quoted as having calculated that the loss of heat from a *lagged* pipe per sq. ft. per annum, is equivalent to 300 lbs. of coal. As to superheat—its efficiency or otherwise depends entirely on the engine. Finally, Mr. Cowan remarked that for boilers to have a low load factor is economical, whereas for engines the reverse is the case, and he quoted an instance in which greater efficiency had been obtained by working four Lancashire boilers at 5 lbs. per sq. ft. of grate surface than by working any one of them at 20 lbs. per sq. ft. of grate surface.

Mr. Pearce strongly emphasised the importance of thoroughly testing fuels, but thought that a better method than the one employed by the author of the paper was to test the values of different coals by their power to evaporate, in actual practice, a given quantity of water; taking note of moisture, ash, and unburnt coal. The price and the evaporative power then decide the giving of the coal contract. Speaking of mechanical stokers, he said that all published particulars of their performances should be accepted with reserve. On the Central London Railway, mechanical stokers and a low-grade fuel were at first employed, only to be replaced later on by hand firing and the use of better coal, resulting in increased economy, though, personally, Mr. Pearce thought that the better fuel had something to do with the good results obtained. With regard to the examination of boilers, this speaker stated that at the Manchester generating stations, using town's water, the boilers only required looking at every 12 months, and the scale formed in that time did not exceed ¼ in. in thickness. He thought

that 2 lbs. coal per sq. ft. radiating surface per 24 hours was the figure to allow for those losses, and this was about 16 times the figure given by Mr. Giles. On the subject of superheat he agreed with what Mr. Cowan had said. Some tests made at Bloom Street generating station on a 3,000-H.P. set, with a load of 1,800 KW., gave the following results for cost of coal per unit:—

Water-tube boilers:—	
Heating surface	5,000 sq. ft.
Grate area	72 sq. ft.
Superheat	90° F.
Temperature of steam at engine...	460° F.
Coal consumed per B.T.U. ...	2·31 lbs.
Corresponding price per unit ...	0·11d.

This was a three-hour test. With a load factor of 20 per cent. for 12 months, and 3·8 lbs. coal consumed per unit, the cost had worked out to 0·125d. per unit. The reduction of steam consumption due to the use of superheat, was shown by the following figures:—

Six-hour test:—	
Load	1,800 KW.
Saturated steam	160 lbs. pressure.
Consumption	19·85 lbs. per KW.-hour.
Using steam superheated 90° F.—	
The consumption was	16·75 lbs. per KW.-hour.

Mr. TAITE thought that as the Lancashire mills worked practically full load 10 hours per day, and then shut down till next morning, their load factor would be said by some people to be 100 per cent.; they were certainly better off than central stations. Table B he considered rather inconclusive, *e.g.*, Bootle had the best load factor, but its coal consumption was more than double the Bradford figures, and even higher than that at the non-condensing stations of Edinburgh and Nottingham. Mechanical stokers were, he thought, economical in this part of the country with the coal generally in use. With coking stokers, fires are apt to get thin at the back, and thus allow large quantities of cold air to leak through—altering the method of feeding, he found, gave much better results. If engineers would take the trouble to analyse their flue gases, they would be able to effect great improvements. At Salford they did not analyse them for a good while, thinking that their combustion was good, and that any small economy which might be effected would not pay the cost of a recording instrument. At last they got an instrument, however, and they had been able to increase their percentage of CO_2 from 5 per cent. to 12 per cent., and found that the recorder thus paid for itself in a single month. Superheaters, in his opinion, were no trouble if properly treated. At Southport 70° superheat at the engine stop valve resulted in a 16 per cent. coal and 17 per cent. steam saving. He remarked how very few stations can give *full* particulars of their state of affairs, and thought that each ought certainly to have coal-weighing apparatus and measure its water either by meter or by the number of strokes per day of the pumps, and know exactly how much power it was expending on the auxiliary plant.

Mr. BENNIS was of the opinion that calorimeter tests on coal, if carefully carried out with good instruments, gave fairly accurate results. He differed from Mr. Cowan as to the economy of a low load factor for boilers, and had found that it paid better to work them as high as 60 lbs. coal per sq. ft. of grate. The percentage of CO_2 in flue gases is not an absolutely reliable factor in determining boiler efficiency, as shown by some tests at Sheffield. In one case, with 13 per cent. CO_2, the boiler efficiency was 80 per cent., and in another case, with only 9·9 per cent. CO_2, it was 89·9 per cent. Pyrometer readings should also be taken. The question of heat transmission, he thought, was of great importance, as this varied as the square of the difference of temperature between the hot gases and the water.

In reply to Mr. Pearce, he wished to state that the mechanical stokers at the Central London Railway generating station were suitable for low grade coal and absolute smoke prevention, and not for a station with a very variable load.

Dr. FENTON considered that the best way for central station engineers to secure a good load factor would be to lower prices for energy even more than present conditions would warrant; if people could get really cheap electricity they would soon take advantage of it, and the supply station would then reap the benefit.

Mr. SEATON, referring to superheat, instanced an engine at Erith working with no less than 800° superheat. The temperature in the high-pressure cylinder was 600° and in the low-pressure 400°. There was no difficulty with lubrication, and the engine had been running four years.

After a few other gentlemen had spoken, Mr. GILES replied. In his experience a better effect was obtained by heating the feed-water rather than the air, as Mr. Cowan suggested. In answer to Mr. Pearce, he would point out that the coal tests extended over a whole week at a time of the year when the load factor was practically constant, and therefore serious differences in results obtained due to the conditions varying would not arise, as Mr. Pearce thought. He quite agreed with Dr. Fenton's remarks as to lowering the price of energy, but central station engineers were generally tied down by their committees, who, as a rule, would take no risks.

A hearty vote of thanks was accorded to Mr. Giles, and the next paper was announced to be read by Mr. W. Chilton on February 2nd, the subject being "Steam Turbines."

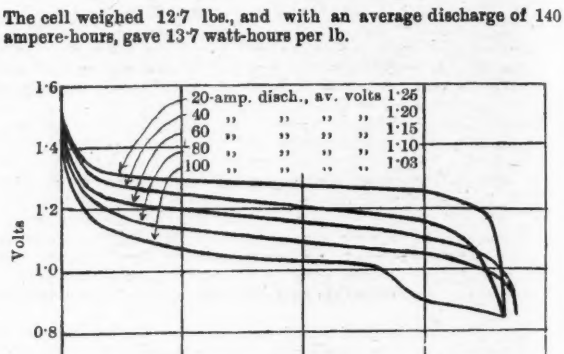
Abstract of discussion on Mr. W. HIBBERT's paper on "The Edison Accumulator for Automobiles."

This long delayed discussion was in many respects disappointing; the champions of the lead cell apparently preferred to lie low.

At the outset Mr. HIBBERT mentioned that additional improvements had been effected in the Edison cell, and gave some particulars of the results which he had obtained from a cell of the latest pattern, including the following data and curves:—

Current.	Ampere-hours.	Watt-hours.	Watt-hours per lb. weight of cell.
20	146	185	14·6
40	146	175	13·7
60	150	172	13·5
80	150	165	13·0
100	146	146	11·8

The cell weighed 12·7 lbs., and with an average discharge of 140 ampere-hours, gave 13·7 watt-hours per lb.



CHARACTERISTIC CURVES, LATEST TYPE EDISON CELL.

Dr. J. A. FLEMING regretted the long delay which had occurred between the reading and the discussion of the paper. He remarked that all who had had these cells under observation, had arrived at practically the same results. The cell which had been under his observation weighed 17·8 lbs., and with an average discharge of 260 amperes, gave 12 watt-hours per lb. fully charged. He considered that the discrepancy in the capacity at different tests depends on the time which elapsed between them. He tested the cell for deposit after four months' working, and found 1·4 grains, which analysis proved to be carbon, iron and nickel. This quantity was infinitesimal, judging from his experience of lead cells. Experiments extending over two months failed to show any local action, which was a very important point. The alkaline solution apparently served only to convey oxygen backwards and forwards. Prof. Fleming could not offer any evidence as to the practical working of a battery of the cells; the average watt-hours per lb. of cell was not distinctly greater than that of many light lead cells, but it had other superior points, such as the absence of deposit and local action, and advantages in the matter of charging and discharging.

The following table is a summary of the results of experiments on a 28-plate Edison automobile cell, obtained in the Pender Electrical Laboratory, University College, London, September, 1903—January, 1904, by Dr. J. A. Fleming, F.R.S., from observations by Mr. W. C. Clinton. The cell in each case was discharged down to 0·8 volt on closed circuit, except in discharge No. 10, where initial voltage was 0·7 volt, and final 0·3 volt. Weight of cell, 17·8 lbs. in all:—

	Discharge.						Charge.	
Number of discharge.	Mean current. Amps.	Mean P.D. Volts.	Max. current. Amps.	Min. current. Amps.	Amp.-hours.	Watt-hours.	Previous charge in A.H.	Average charging rate. Amps.
1	30·6	1·224	32	22·6	173	212	900	30
2	30·0	1·214	32	19·0	173	210	660	60
3	31·9	1·208	33	20·0	159·5	193	274	60
4	28·7	1·216	32	17·0	168·5	205	269	60
5	51·4	1·179	57	31·0	155·5	183	262	60
6	60·5	1·192	69	36·0	145	173	225	100
7	72·9	1·147	80	41·0	142	163	225	100
8	91·5	1·117	112	62·0	143·5	160	230	100
9	93·5	1·161	116	60·0	154	178	237	100
10	266·2	0·49	375	170	115·5	57	245	100
11	40	1·197	42·0	24·5	150	179	281	97
12	34	1·211	36	21	130	158	184	92
13	23	1·231	24	13	143	176	237	95
14	29·9	1·234	30	17	142	175	315	105
2 months' rest charged.								
15	11·4	1·273	11·6	8·5	141	179	283	105
16	45	1·200	45	45	154	184	390	80
17	30	1·245	30	30	159	198	436	32
18	30	1·249	30	30	161	201	225	60
19	30	1·245	30	30	160	199	336	60

At end of 13th discharge cell was short-circuited for 16 hours

Mr. E. J. WADE, commenting on the paper, remarked that all the results were "outside" ones; he wished for some information as to the internal working of the cell. With reference to the curve of discharges shown in fig. 2 of the paper, he recalled the fact that Mr. Hibbert had previously ascribed the variations of potential to

variations in the strength of the electrolyte. In this case there was apparently no change in the electrolyte, and he was curious as to the possible explanation. He had tried the use of very highly porous active material, and obtained similar results to those obtained in the Edison cell.

Mr. H. L. Joly recalled a German cell, constructed with nickel-peroxide and iron plates, which had given similar results to the Edison cell, but it was not so mechanically constructed. He was understood to defend the lead cell for automobile work.

Mr. W. R. Cooper considered the automobile used for the tests very heavy for the work it did. He contended that the capacity should be taken as a basis and not the weight, then the discharges would not be excessive. He further found fault with the efficiency of the cell, considered that 85 per cent. efficiency for the motor was too high, and noted that mention of the gearing was omitted.

Mr. W. H. Patchell offered a few remarks, and Mr. Hibbert replied.

In reference to the formation of the cell, he considered that the long charge necessary after a period of disuse only dealt with oxidisation incurred during that time, and was not the same as a laboratory formation. In the matter of deposit, he had tested a cell which had run some 3,000 miles, and been very roughly used in a cab, and found some $\frac{1}{1000}$th of the active materials deposited in similar proportions to those given by Dr. Fleming. He considered that the fact that polished iron was unaffected by alkaline solutions had been abundantly demonstrated. His experience had extended over 60 Edison cells, with uniform results, and those published could be accepted without reserve. In regard to the internal action of the cell, he suspected that many oxides were formed during cell action, and suggested that the E.M.F. variations shown by the discharge curves might be accounted for by the variable resistance during discharge, particulars of which were given in the paper. The figure, 600 watt-hours, given by him as about the limit output before change of capacity occurs in the case of lead batteries, was an average figure obtained from data supplied by several users. He had found 5 cells out of 60, which had been subjected to excessive loads in a cab, impaired in capacity; one cell normally giving 158 ampere-hours had gone down to 75—80 ampere-hours capacity, but this he had revived to the extent of 122 ampere-hours by regeneration, and believed it would quickly regain its original figure.

Abstract of discussion on the paper on "Magnetic Dispersion in Induction Motors," by Dr. Hans Behn-Eschenburg.

Dr. C. V. Drysdale observed that we were much indebted to Continental engineers for papers of this kind. He had made some tests on two 3-h.p. three-phase motors in the laboratory of the Northampton Institute. The proportions of the stampings of these machines were very similar to those recommended in the paper. He considered that the direct voltage test, applied to the rotor and stator, was the best and easiest for obtaining the value of the coefficient of dispersion. In using the current method, three ammeters were required owing to the varying currents in the different circuits, also there were theoretical objections to taking the no-load current, which required corrections for core loss and necessitated wattmeter observations as well. He had obtained similar results from both methods. The two small motors under test gave a dispersion coefficient of ·06, which he considered a good value for a small machine. By the current method he obtained a coefficient of ·0645; by Dr. Behn-Eschenburg's method of calculation, however, he obtained a coefficient some 13 per cent. less in value, and this difference was too large for practical work.

Mr. H. M. Hobart sent a written contribution.

PROGRESS IN ELECTRO-CHEMISTRY AND ELECTRO-METALLURGY IN 1903.

By JOHN B. C. KERSHAW, F.I.C.

Introduction.—No striking discoveries or developments have occurred in industrial electro-chemistry or electro-metallurgy during the year 1903. The electrolytic alkali industry has been handicapped by the low price of bleaching powder, and several of the Continental works have been compelled to shut down, or to use their chlorine for other purposes. The calcium carbide industry is only slowly recovering from the effects of early over-capitalisation and over-production. The experimental trials of the electric furnace for iron and steel production are being continued, and considerable success is reported to have been attained at La Praz, France, in the production of tool-steel.

The production of nitric acid and nitrates at Niagara by high-tension electric discharges is still in its experimental stage, and doubts have been raised as to the industrial value and future of the process. Ozone as an agent for water purification has made progress during the past year, and water-purification works of considerable size are now in operation at several places on the Continent of Europe. Details of these and other processes and manufactures, will be found under the respective headings in the following *résumé* of the progress of the year 1903.

Aluminium.—Aluminium has remained stationary in output and price during 1903, but the use of the metal is undoubtedly extending, and a considerable increase in production is likely to occur in the near future. The patent litigation in the United States between the owners of the Cowles and Bradley Patents, and the Pittsburg Reduction Co., has ended in a victory in the Appeal Court for the former, and the Pittsburg Reduction Co. is reported to have paid a large sum for past infringements, and to be now working under a royalty agreement with the Cleveland Co. The number of works producing aluminium is nine, with two in course of erection. The aggregate power available for the manufacture is still about 40,000 h.p., equivalent to a production of 11,500 tons per annum, if no other products were made in the aluminium works.

The actual production at the present time, according to the most recent and reliable estimates is, however, only 7,500 tons, and there is a considerable margin between the maximum, and actual, production figures.

In the face of this discrepancy, it is somewhat surprising to find that three of the companies engaged in the manufacture (the Neuhausen Aluminium Industrie Gesellschaft, the Pittsburg Reduction Co., and the British Aluminium Co.), are taking steps to increase their productive capacity; and this action on their part would seem to indicate that a rapid increase in the consumption of the light metal is expected in 1904.

As regards utilisation, the applications of aluminium as an electrical conductor were discussed at length in these columns by the author recently.*

In lithography, aluminium is making rapid progress as a substitute for stone, and the writer has been informed by the manager of the Aluminium Rotary Press, Ltd., that already 18 printing firms in this country have adopted aluminium for colour work. The writer had recently an opportunity of seeing an aluminium rotary press in operation at Messrs. W. H. Smith & Sons' lithographic works in London, and the work produced was quite satisfactory to those in charge of the press. Since aluminium offers many advantages when compared with stone, this use of the light metal is certain to extend.

The use of aluminium powder for producing alloys or molten iron at a very high temperature, is being exploited by the firm of Goldschmidt, of Essen, with considerable success, and 100 tons of aluminium in the form of powder is now being consumed per annum for the manufacture of "Thermit," the mixture of aluminium powder and ferric oxide sold for welding purposes. Agencies for the sale of this product have recently been established in England and America.

The most recent and novel application of aluminium is its use for the manufacture of explosives. An explosive has been patented by Führer, of Vienna, under the name of "Ammonal," and a company has been floated in London with a capital of £100,000 for the exploitation of this new manufacture. Ammonal is stated in the original patent specification (No. 16,277 of 1900) to be composed of carbon, ammonium nitrate and aluminium powder in the proportions represented by C, 4 NH_4 NO_3, 2 Al, and on firing, a 20-gram charge is said to yield 2,000 cc. of gas. The aluminium powder is added to raise the temperature of the gases, and thus to intensify the explosive effect.

Alkalies and Bleach.—The chief feature of the year 1903 in the electrolytic alkali industry has been the open competition between the electrolytic and Le Blanc manufacturers in the sale of their output of bleaching powder, and the consequent low price for this product which has ruled throughout the year. The agreement that for three years had regulated the sale of Bleach in England and Germany was allowed to lapse in December, 1902, and bleaching powder at once fell from £6 10s. to £3 15s. per ton, and has remained practically at that price throughout the last twelve months. The full effects of this fall in the value of one of their chief products upon the balance-sheets of the various electrolytic alkali companies is not yet known, but the two English companies have both shown diminished receipts for the first half of 1903, and in the case of the Middlewich Co., the dividend on both classes of shares has been passed. It will, therefore, be a relief to those interested

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* Electrical Review, September 18th, 1903, and October 23rd, 1903.

financially in the electrolytic alkali industry, to learn that the agreement between the Le Blanc and electrolytic manufacturers as regards production and price of bleach has been revived in a modified form, and the year 1904 will, therefore, open under more favourable conditions than 1903, for the electrolytic alkali works.

Little new information relating to the progress of the industry in Europe has been published during 1903. In France only two works are working successfully, namely, at La Motte, where the Elektron (Griesheim) process is operated with 2,000 H.P. (steam), and at Moutiers, where the Outhenin-Chalandre process is in operation. Owing to the fall in the value of bleach, the last-named company has been devoting a portion of its chlorine production to the manufacture of carbon tetrachloride in place of bleach. In Switzerland the two electrolytic alkali companies are reported to have ceased production, owing to the financial difficulties caused by the fall in values, and also to the high cost of fuel for evaporating the caustic alkali liquors.

The industry is slowly developing in Italy, where large developments of water-power for electro-chemical undertakings are now occurring, and there are electrolytic alkali works in operation at Bussi and at Piano, the Outhenin-Chalandre process being in use here.

In the United States, the electrolytic alkali industry is more widely developed than in this country, and in recent papers Prof. Haber and E. Hart have given details of numerous plants in various parts of the States, where bleaching powder is being produced by the electrolysis of brine in cells of the diaphragm type.

The Dow Chemical Co., at Midland, Michigan, owns the largest of these, and is reported by Hart to be producing 40 tons of high-strength bleach per day. The Moore cell, which resembles that of Hargreaves and Bird, is about to be employed on an extended scale at Rock Glenn, near Buffalo. In many of these plants only the chlorine is utilised, the soda liquors being run to waste. The imports of bleaching powder into the States from European countries have steadily declined in recent years, and in 1902 the U.S.A. production of bleach (all electrolytic) was estimated to amount to 34,000 tons, while the total home consumption was placed at 79,000 tons. Nearly one-half of the domestic consumption is therefore now covered by the home output of this product.

(To be continued.)

NEW PATENTS APPLIED FOR, 1904.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

1,209. "Improvements in the recording gear for electricity and other meters." H. Webber. January 18th.

1,222. "A method of automatically timing the electrical firing of internal combustion engines." E. H. Micklewood and S. Currin. January 18th.

1,225. "A terminal for making neat and finished ends to electric wires and cables." E. Apted. January 18th.

1,242. "Improvement in party line telephone systems." W. W. Dean. (Date applied for under Patents Act, 1901, June 15th, 1903, being date of application in United States.) January 18th. (Complete.)

1,258. "Improvements in electric clocks." G. S. Tiffiny and J. Van Inwagen. January 18th. (Complete.)

1,279. "Improvements in the production and manufacture of pipes or conduits or other articles for use underground or in other situations where they are subject to electrical or corrosive action." J. Y. Johnson. (L. A. Brown and D. Tredway, United States.) January 18th. (Complete.)

1,296. "Improvements in electrical ignition apparatus for internal combustion engines." A. J. Postans. January 18th. (Complete.)

1,307. "Improvements in electric condensers." I. Moscicki. January 18th. (Complete.)

1,308. "Improvements in high tension electric condensers. I. Moscicki. January 18th. (Complete.)

1,314. "Improvements in electric igniters for explosion motors" C. Ropiquet and A. Daveluy. (Date applied for under Patents Act, 1901, May 30th, 1903, being date of application in France.) January 18th. (Complete.)

1,326. "Improvements in or relating to electrical switches." V. Hope, V. H. Sugden and W. Gardner. January 19th.

1,363. "Improvements in electric bells and pushes, so that either a light can be obtained or a bell made to ring from the same batteries over the ordinary bell wiring." E. Liddle and G. E. Druiff. January 19th.

1,364. "Improvements in or relating to gas or vapour electric apparatus." F. W. Le Tall. (The Cooper-Hewitt Electric Co., U.S.A.) January 19th.

1,374. "An improved method of and means for regulating electric motors." J. G. V. Lang. January 19th. (Complete.)

1,414. "Telephone relay." B. Gati. January 19th. (Complete.)

1,473. "Apparatus for indicating leakage in electric circuits." H. H. Kenshole. January 20th.

1,481. "Improvements in alternating current electric motors." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) January 20th.

1,482. "Improvements in alternating current electric motors." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) January 20th.

1,483. "Improvements in alternating current motors." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) January 20th.

1,484. "Improvements in controlling electric motors." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) January 20th.

1,494. "Improvements in alternating current dynamos." M. Latour. (Date applied for under Patents Act, 1901, January 21st, 1903, being date of application in France.) January 20th. (Complete.)

1,513. "Improved shade carrier holder for bayonet or screw electric lamp holders." P. Escare. January 21st.

1,539. "An improved system for limiting the destructive effect of an electric arc accidentally formed within a generating station, and a method for the automatic supply of light during and after a breakdown." H. W. Clothier. January 21st.

1,542. "An improved type of street junction box for the distribution of electrical energy." T. Cohen. January 21st.

1,549. "Improvements connected with electric cable troughs or conduits." The Seacombe Pressed Brick and Tile Works, Ltd., and F. P. Jones. January 21st.

1,624. "A new or improved device for preventing accidents from overhead trolley wires when broken." A. B. Mudie. January 22nd.

1,641. "Improvements in apparatus for arranging and displaying telephonic addresses and for such like uses." A. V. Hunt. January 22nd.

1,642. "Improvements in and relating to electric switchboards." The British Thomson-Houston Co., Ltd., E. B. Wedmore and J. Whitcher. January 22nd.

1,654. "An improved process for the production of electrotypes." Sherard Cowper-Coles & Co., Ltd., and S. Cowper-Coles. January 22nd.

1,676. "Improvements in processes for manufacturing electrodes for arc lamps." A. Blondel. January 22nd. (Date applied for under Patents Act, 1901, February 5th, 1903, being date of application in France.) (Complete.)

1,714. "Improvements in electrical signalling apparatus." A. Pieper. January 22nd. (Complete.)

1,785. "Improvements in connection with conductors for the trolley system of electric traction." H. G. Nicholson. January 23rd.

1,794. "Improvements in or relating to electric clocks." F. Hope-Jones and C. L. Sumpter. January 23rd.

1,799. "Improvements in electricity meters." W. M. Mordey and G. C. Fricker. January 23rd.

1,800. "Improvements in electric mining lamps." Van Raden & Co., Ltd. (Gulcher-Accumulatoren-Fäbrik G. m.b. H. Germany.) January 23rd.

PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d. (in stamps).

1903.

Current Transformers used in Conjunction with Instruments Measuring the Energy in Alternate Current Electric Circuits. A. C. Heap. 47. January 1st.

The Control of the Speed of Direct Current Dynamos and Motors. E. J. Javaux and A. M. L. Barbou. 455. January 7th.

Electric Switches. E. A. Carolan. (The General Electric Co., United States.) 1,064. January 15th.

Electric Lighting Systems. J. F. McElroy. 1,095. January 15th.

Safety Appliances for the Prevention of Injury where a Trolley Line or other Live Conductor Breaks. W. H. Stewart. 1,299. January 19th.

Miners' Electric Lamps. H. G. Prested. 1,416. January 20th.

Couplings for Metal Tubes containing Electric Wires. J. G. Barber. 2,030. January 28th.

Electrically Actuated Semaphores. Siemens Bros. & Co., Ltd., and L. M. G. Ferreira. 2,961. February 7th.

Electric Resistances and the Like. F. Le Roy. 3,873. February 18th.

Electric Telegraph Apparatus. E. Vanzeitti. (A. Levy, Italy.) 3,986. February 19th.

Hand Tools for Linesmen. S. Kirlin. 4,414. February 25th.

Connection between Terminal and Trolley Head of Electric Tramcars. T. B. Birkby. 5,619. March 11th.

Detecting whether Railway or like Points are in their Correct Position and an Electrical Switch for use therewith. Siemens Bros. & Co., Ltd., and L. M. G. Ferreira. 7,026. March 26th.

Electric Hair Brushes. J. S. Collins. 7,742. April 3rd.

Systems of Electrical Distribution. J. C. Slaughter. 8,259. April 9th.

Overhead Line and Travelling Contacts (Trolley) for Electric Traction of any kind. E. Bauco. 10,384. May 7th.

Radiator Systems for Wireless Telegraphy. A. Blondel. (Date applied for under Patents Act, 1901, May 27th, 1902, being date of application in Belgium.) 11,427. May 19th.

Section Insulating Bridges for Electric Overhead Conductors. H. B. Harris. 11,552. May 20th.

Electric Signalling Apparatus for Railway Trains. A. Bonemeyer. 15,048. July 7th.

Safety Devices for Strong Current Overhead Conductors. C. C. van der Valek. 17,367. August 10th.

Machine for Making Battery Grids. T. J. Coster and Smith Storage Battery Co. 18,323. August 25th.

Telegraph Apparatus. O. Imray. (Societe des Telegraphs Multiplex (Systeme E. Mereadiar), France.) 18,867. September 1st.

Telephone Receiver-holders. A. J. Briggs. 19,250. September 7th.

Manhole Terminals for Electrical Conduit Systems. G. M. Gest. 19,524. September 10th.

Protecting the Terminals of Electric Apparatus and Ensuring good Electrical Contact. W. Peto. 19,748. September 14th.

Automatic Circuit Breakers. F. P. Wetmore. 20,230. September 19th.

Apparatus for Disinfecting Telephones. N. J. Tubbs, R. H. Smith and I. S. Hartley. 21,574. October 7th.

Telephone Attachments. W. S. Haddock. 21,851. October 10th.

Coupling Apparatus for Tapping Circuit Wires. T. E. Daniels, jun. 22,101. October 13th.

Electrical Ceiling Fittings. C. M. Dorman and R. A. Smith. 22,432. October 17th.

Electrical Winding. Siemens Bros. & Co., Ltd. (Siemens & Halske Actien Gesellschaft, Germany.) 22,572. October 19th.

Safety Fuse Device for Electrical Installations. Siemens Bros. & Co., Ltd. (Siemens & Halske Actien Gesellschaft, Germany). 22,573. October 19th.

Covers and Frames for Junction Boxes. S. Robinson. 22,639. October 20th.

Brush Holders for Dynamo-electric Machines. M. E. Thompson. 22,643. October 20th.

Contact Apparatus for Electric Relay Master Clocks. O. Imray. (Siemens-Schuckertwerke G.m.b.H. Germany). 22,664. October 20th.